Fishery Management Report No. 11-13

A Compilation of the 2010 Spiridon Lake Sockeye Salmon Enhancement Project Results: A Report to the Kodiak National Wildlife Refuge

by

Steven Thomsen

March 2011

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_{2}, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY MANAGEMENT REPORT NO. 11-13

A COMPILATION OF THE 2010 SPIRIDON LAKE SOCKEYE SALMON ENHANCEMENT PROJECT RESULTS: A REPORT TO THE KODIAK NATIONAL WILDLIFE REFUGE

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The Kodiak Regional Aquaculture Association (KRAA) funds the general operations of the Spiridon Lake sockeye salmon stocking project and Pillar Creek Hatchery. The Division of Commercial Fisheries provides biological oversight and evaluation in the management of returning adult runs to the enhanced or rehabilitated systems associated with hatchery stocking projects.

The Fishery Management Reports series was established in 1989 by the Division of Sport Fish for the publication of an overview of management activities and goals in a specific geographic area, and became a joint divisional series in 2004 with the Division of Commercial Fisheries. Fishery Management Reports are intended for fishery and other technical professionals, as well as lay persons. Fishery Management Reports are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone regional peer review.

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ABSTRACT

A sockeye salmon *Oncorhynchus nerka* enhancement stocking project was initiated at Spiridon Lake in 1990 to provide increased harvest for fishermen in the Kodiak Management Area. Because Spiridon Lake lies within the boundaries of the Kodiak National Wildlife Refuge, the Spiridon Lake Management Plan directs the Alaska Department of Fish and Game to collect water quality and zooplankton data, estimate the smolt outmigration, record juvenile salmon stocking numbers, document the commercial salmon harvest in Telrod Cove, and monitor natural salmon runs emigrating into Spiridon River to ensure the project remains compatible with the Kodiak National Wildlife Refuge mission.

In 2010, Spiridon Lake had a total nitrogen to total phosphorus ratio of 287:1, a total ammonia level of 4.2 μg/L at the 1m depth, and a chlorophyll-*a* concentration of 0.42 μg/L. The lake's zooplankton community had a *Diaptomus* to *Cyclops* ratio of 0.21:1, a copepod biomass of 4.3 mg/m^3, a *Bosmina* to *Daphnia* ratio of 3.28:1, a cladoceran biomass of 2.84 mg/m^3, and a *Bosmina* size (average length) of 0.47 mm. The 2010 Spiridon Lake enhancement project met all the KNWR monitoring criteria, except for the total nitrogen to total phosphorus ratio, *Bosmina* to *Daphnia* ratio, and *Bosmina* size. In 2010, an estimated 669,343 sockeye salmon smolt emigrated from Spiridon Lake and a total of 3,006,265 sockeye salmon juveniles were released into the lake. A total of 100,727 adult sockeye salmon were harvested in the Spiridon Bay Special Harvest Area, as reported on commercial fish harvest tickets. The Spiridon Lake enhancement project contributed an estimated 174,473 adult sockeye salmon to the commercial harvest within the Kodiak Management Area. In 2010, a stocking release of approximately 2.0 million fry was recommended for Spiridon Lake in 2011.

Key words: Spiridon Lake, Telrod Cove, Spiridon Bay Special Harvest Area, SBSHA, Kodiak Management Area, *Oncorhynchus nerka*, sockeye salmon, stocking, Kodiak National Wildlife Refuge, KNWR, U.S. Fish and Wildlife Service, USFWS, Kodiak Regional Aquaculture Association, KRAA, Special Use Permit, limnology, zooplankton.

INTRODUCTION

Spiridon Lake (57°40' N lat, 153°39' W long) is located in the Kodiak Unit of the Kodiak National Wildlife Refuge (KNWR) on the northwest side of Kodiak Island (Figure 1), approximately 74 km west of the City of Kodiak. The lake is 9.6 km long, 1.6 km at its widest point, has a surface area of 9.2 km^2, and a volume of 318 km^3 (Figures 1 and 2; Schrof and Honnold 2003). Spiridon Lake is at an elevation of 136 m, has a mean depth of 34.7 m, and a maximum depth of 82.0 m (Figure 2). The Spiridon Lake outlet stream (Telrod Creek) is approximately 2.0 km long and empties into Telrod Cove. Telrod Creek has three waterfalls that are impassable to fish. Two of the waterfalls are located approximately 0.8 km downstream of the lake outlet, a third waterfall, located near the stream terminus, blocks salmon from migrating further upstream. Resident fish in Spiridon Lake include rainbow trout *Onchorhynchus mykiss*, Dolly Varden char *Salvenlinus malma*, threespine stickleback *Gasterosteus aculeatus*, and freshwater sculpin *Cottus aleuticus* (Honnold 1997).

The impetus behind starting an enhancement project at Spiridon Lake is that the system does not support an anadromous fish run due to the barrier falls that prevent upstream migration from the ocean. The stocking project was initiated to utilize the lake's freshwater rearing environment without dramatically altering the nutrient balance or forage base (macrozooplankton) of the lake. Sockeye salmon fry are stocked into the lake at levels based on in-season limnological assessments of nutrients and zooplankton biomass (forage). Studying the stocking of a barren lake also provides researchers and managers with the opportunity to thoroughly assess the response of the macrozooplankton community to predation by juvenile salmon (Kyle 1996).

In December 1990, the Alaska Department of Fish and Game (ADF&G) in cooperation with Kodiak Regional Aquaculture Association (KRAA) submitted a proposal to the United States

Fish and Wildlife Service (USFWS) to begin a sockeye salmon *O. nerka* stocking project at Spiridon Lake. The KNWR permitted ADF&G to begin stocking Spiridon Lake to determine if a stocking project would be feasible and compatible with the guiding principles of the KNWR (Chatto 2000). The KNWR prepared an environmental assessment for the proposed project, which found no significant impact for the enhancement project (USFWS 1991). The following year, the KNWR issued a temporary five-year Special Use Permit (SUP) for the Spiridon Lake project to ADF&G. The SUP allowed ADF&G to proceed with the stocking project, so that additional baseline data could be collected to evaluate the stocking impacts to the lake's ecological community and potential impacts to local wildlife from adults returning to Telrod Cove. In 1997, ADF&G consolidated and thoroughly evaluated all available fishery and limnological data from the Spiridon Lake stocking project into one document (Honnold 1997), which was used as a reference by the KNWR to write the Spiridon Lake Management Plan (SLMP; Chatto 2000). The SLMP was authorized by the KNWR in June 2000 along with a 5-year renewable SUP (updated every five years) to continue stocking sockeye salmon, monitoring the lake ecosystem, and determining sockeye salmon production from Spiridon Lake.

Juvenile sockeye salmon have been stocked annually into Spiridon Lake since 1990 (Foster et al. 2010a). In 2010, the brood source utilized for stocking Spiridon Lake was from Saltery Lake. Historically, juvenile sockeye salmon stocked into Spiridon Lake have come from either Upper Station or Saltery lakes. Juvenile salmon are stocked aerially, via fixed-wing aircraft.

Since 1991, smolt migrating out of Spiridon Lake have been enumerated and sampled annually to estimate the abundance, age, weight, length (AWL), and condition of the smolt outmigration. The returning adult sockeye salmon are harvested in the Spiridon Bay Special Harvest Area (SBSHA; Figure 1) as well as other westside harvest areas, since 1994. The commercial fishery has been monitored and sampled annually to estimate the abundance, age, sex, and length (ASL) of the sockeye salmon commercial catch in Telrod Cove.

Seasonal zooplankton production commonly varies from year to year and fluctuates considerably within a given season. The variation in production can be attributed to many factors especially, environmental variation, predation, and inter-competition for habitat (Kyle 1996). Maintaining Spiridon Lake's biological integrity while maximizing sockeye salmon smolt production necessitates an understanding of these complex interactions.

Previous review of zooplankton interactions in Spiridon Lake consisted of a limited data set and could only conclude that juvenile sockeye salmon stocking did not appear to affect zooplankton composition (Honnold 1997). Assuming some influence based on conclusions from other lake studies, stocking levels in Spiridon Lake were recommended based on zooplankton species composition and abundance. Thomsen (2010) began exploring zooplankton interactions in Spiridon Lake further.

MANAGEMENT PLAN MONITORING CRITERIA

Monitoring criteria (Table 1) were established from data collected at Spiridon Lake from 1987 to 1999 (Appendix A1, A2, and A3). The SLMP contains specific limnological and fishery guidelines to ensure that juvenile sockeye salmon stocking levels do not substantially change Spiridon Lake. Specific attributes monitored include lake nutrient concentrations (nitrogen, phosphorus, and ammonia); chlorophyll *a*, zooplankton composition, density, and biomass; smolt production; and adult harvest estimates (Chatto 2000).

The SLMP documents the various components of the stocking project, outlines how the project will be managed to remain compatible with the KNWR's mission, and serves as a reference document to guide any proposed changes to project operations (Chatto 2000). This report consolidates and summarizes the 2010 and historical data collected as part of the Spiridon Lake sockeye salmon enhancement project and compares these data to the SLMP guidelines.

MANAGEMENT PLAN OBJECTIVES

The management plan contains six objectives:

1. Monitor water quality in Spiridon Lake to ensure compatibility with the SLMP criteria.
2. Monitor zooplankton in Spiridon Lake to ensure compatibility with the SLMP criteria.
3. Estimate the number of outmigrating sockeye salmon smolt and evaluate their growth and survival.
4. Stock juvenile sockeye salmon at densities based on the analysis of current and historical limnological data.
5. Document the commercial salmon harvest within the SBSHA to monitor the interception of natural salmon stocks and evaluate supplemental commercial harvest.
6. Estimate pink, chum, and coho salmon escapements into the Spiridon River by aerial survey (stream #254-401; not a part of Spiridon Lake Drainage; Figure 1).

METHODS

LIMNOLOGICAL MONITORING

Comparative criteria specified in the SLMP were: total nitrogen (TN) to total phosphorus (TP) ratio, total ammonia (TA), chlorophyll *a* (Chl *a*), *Diaptomus* to *Cyclops* density ratio, copepod biomass, *Bosmina* to *Daphnia* density ratio, cladoceran biomass, and cladoceran (*Bosmina*) average size.

Lake Sampling Protocol

Samples were collected from Spiridon Lake five times from May to September at approximately four-week intervals. Two sampling stations were established in the deepest basins of the lake using a Global Positioning System (GPS; Figure 2). Samples were collected following standard ADF&G sampling procedures from Koenings et al. (1987), Thomsen (2008), and Foster et al. (2010b).

Water samples for chemistry and nutrient analysis were collected at the 1-m (epilimnion) and 50 m (hypolimnion) depths using a 4-L Van Dorn bottle and emptied into separate, pre-cleaned polyethylene carboys, which were kept cool and dark until processed at the Near Island Laboratory (NIL) in Kodiak. Vertical zooplankton hauls were made at each station using a 0.2 m diameter conical net with 153 µm mesh. The net was pulled manually at a constant speed (~0.5 m/s) from approximately 50 m to the lake surface. The contents from each tow were emptied into a 125 ml polyethylene bottle and preserved in 10% neutralized formalin.

General Water Chemistry and Nutrients

Unfiltered water was analyzed for TP, Total Kjeldahl Nitrogen (TKN), pH, and alkalinity. Sample water was filtered through a rinsed 4.25 cm diameter Whatman™[1] GF/F filter pad and stored frozen in phosphate free soap-washed polyethylene bottles. Filtered water was analyzed for total filterable phosphorus (TFP), filterable reactive phosphorus (FRP), nitrate + nitrite (N+N), and TA. A Spectronic Genesys 5 Spectrophotometer (SG5) was used for TP, TFP, FRP, N+N, and TA analyses.

The potassium persulfate-sulfuric acid digestion method described in Koenings et al. (1987) and Thomsen (2008) adapted from methods in Eisenreich et al. (1975) was used for TP analysis. Unfiltered frozen water samples were sent to the South Dakota State University laboratory for the TKN analysis using the EPA 351.3 (Nesslerization; AWWA 1998) method. The pH of water samples was measured with a Corning™ 430 meter, while alkalinity (mg/L as $CaCO_3$) was determined from 100 ml of unfiltered water titrated with 0.02 N H_2SO_4 to a pH of 4.5 and measured with a Mettler Toledo™ Seven Easy pH meter. Separate meters were used for the measurement of pH and alkalinity for added speed and accuracy.

Determination of TFP used the same methods as those for TP utilizing filtered water. The potassium persulfate-sulfuric acid method described in Koenings et al. (1987) and Thomsen (2008) was used for FRP analysis. Samples for N+N were analyzed using the cadmium reduction column method described in Koenings et al. (1987) and Thomsen (2008). The phenol-sodium hypochlorite method described in Koenings et al. (1987) and Thomsen (2008) was used for determining TA. Total nitrogen, the sum of TKN and N+N, were calculated for each sample in addition to the ratio of total nitrogen to total phosphorus.

Chlorophyll *a*

For Chl-*a* analysis, 1.0 L of water from each sample was filtered through a Whatman™ GF/F filter under 15 psi of vacuum pressure. Approximately 5 mL of magnesium chloride ($MgCO_3$) was added to the final 50 mL of water near the end of the filtration process for sample preservation. Filters were stored frozen and in individual plexiglass slides until analyzed. Filters were then ground in 90% buffered acetone using a mortar and pestle, and the resulting slurry was refrigerated in separate 15 mL glass centrifuge tubes for 2 to 3 hours to ensure maximum pigment extraction. Pigment extracts were centrifuged, decanted, and diluted to 15 mL with 90% acetone (Koenings et al. 1987; Thomsen 2008). The extracts were analyzed using a SG5 Spectrophotometer using methods described by Koenings et al. (1987) and Thomsen (2008). The chlorophyll-*a* measurements were averaged from water samples collected at both sampling stations.

Phytoplankton

For phytoplankton analysis, 4.0 ml of Lugol's acetate was added to 200 ml of water withdrawn from the contents of the 1 m water sample carboy. Methods were adapted from those described in Koenings (1987) and Thomsen (2008). Samples were sent to the Canadian Museum of Nature (Ottawa, Ontario) for analysis.

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[1] Product names used in this publication are included for completeness but do not constitute product endorsement.

Zooplankton

For zooplankton analysis, cladocerans and copepods were identified according to taxonomic keys by Thorp and Covich (2001), Wetzel (1983), and Edmondson (1959). Zooplankton were individually measured in triplicate 1 mL subsamples taken with a Hansen-Stempel pipette and placed in a Sedgewick-Rafter counting chamber. Lengths from a minimum of 15 animals of each genus or species (typically animals are grouped at the genus or species level) if possible were measured to the nearest 0.01 mm. A student's t-test was then employed to determine the number of measurements needed to meet sample size requirements (Koenings 1987 and Thomsen 2008), and the mean was calculated. Density was reported as the number of individuals per unit volume (no./m^3). Biomass was estimated using density and weight, using species-specific linear regression equations between length and dry weight derived by Koenings et al. (1987). Zooplankton data from the two stations were averaged for each survey date.

STOCKING

Stocking densities for Spiridon Lake were determined by estimating the lake's rearing capacity based on inseason zooplankton biomass from May through July, prior to the hatchery egg takes (Finkle and Byrne 2010). Saltery Lake sockeye salmon eggs were collected in early September of 2009 by Pillar Creek Hatchery (PCH) personnel using standard fish culture procedures (ADF&G 1994). Eggs were flown back to Kodiak, incubated and reared at PCH, and the juvenile salmon were then aerially released into Spiridon Lake via fixed-wing aircraft on two occasions in June.

SMOLT MONITORING

Personnel monitored, estimated, and sampled the sockeye salmon smolt emigration exiting Spiridon Lake, through Telrod Creek (Appendix B1 and B2). Sockeye salmon smolt that emigrated from the lake were trapped using of two Canadian fan-traps and then funneled into a counting tank. All smolt were then counted and released into a pipeline bypass system that circumvented the barrier falls (Chatto 2000; Foster et al. 2010a). A subset of smolt were measured, weighted, and sampled for later aging before release. A 15-cm diameter black polyethylene pipeline provided smolt passage around the falls, carrying water and smolt approximately 0.75 km, dropping about 90 m in elevation before emptying into lower Telrod Creek. Abundance was estimated using timed counts when smolt passage exceeded the sampling box capacity (approximately 1,000 smolt per hour). Detailed methods for using timed counts are provided in Foster et al. (2010a). Forty smolt were sampled five days a week for AWL data (Foster et al. 2010a). Once smolt emigration ceased, the bypass system was removed from the creek and stored on the stream banks.

HARVEST MONITORING

Commercial harvest within the SBSHA was monitored by personnel stationed at a camp on the outer eastern shoreline of Telrod Cove (Figure 1). Personnel recorded fishing effort, estimated the commercial catch by species, and sampled a portion of the sockeye salmon catch for ASL data (Foster et al. 2010a; Schrof and Honnold 2003). The ADF&G fish ticket database was used to generate end-of-season catch summaries and to confirm on-site estimates.

ESCAPEMENT MONITORING

Aerial surveys of the Spiridon River drainage and Spiridon Bay were conducted in July and August with fixed-wing aircraft. Live and dead salmon were enumerated by species.

RESULTS

SPIRIDON LAKE MONITORING PLAN CRITERIA

Total Nitrogen to Total Phosphorus Ratio

The seasonal mean total nitrogen to total phosphorus ratio (TN:TP) in Spiridon Lake was 287:1 in 2010 (Tables 1 and 2; Appendix A3), which was above the desired range of 148:1 to 273:1, specified in the SLMP (Table 1). The 2010 seasonal mean was higher than the historical average of 227:1 from 1990 to 2009 (Table 2).

Mean Total Ammonia

The 2010 seasonal mean concentration for total ammonia was 4.2 µg/L and averaged 4.2 µg/L at both Stations 1 and 2 (Tables 1 and 3). The 2010 seasonal mean ammonia concentration was lower than the average concentration (5.8 µg/L) during the years (1990–2009) of stocking, but was within the desired range of 1.6 to 11.2 µg/L specified in the SLMP (Tables 1 and 3).

Mean Chlorophyll *a*

Seasonal Chl-*a* levels in Spiridon Lake averaged 0.42 µg/L at the 1-m depth in 2010 (0.36 µg/L at Station 1 and 0.47 µg/L at Station 2; Tables 1 and 3). The average Chl-*a* concentration was within the specified range of 0.1 to 1.0 µg/L (Table 1). The seasonal average Chl-*a* concentration was near the historical 1990 to 2009 mean of 0.46 µg/L (Table 3).

Mean Copepod Biomass

The average density of copepods in Spiridon Lake in 2010 was 1,547 No./m^3 and an average biomass of 4.3 mg/m^3, which was within the criteria range of 3.5 to 21.7 mg/m^3 identified in the SLMP (Tables 1, 4, and 5). The average copepod density from 1990 to 2009 was 4,154 No./m^3 and the average biomass was 9.0 mg/m^3 (Tables 4 and 5).

Diaptomus to Cyclops Density Ratio

The *Diaptomus* to *Cyclops* ratio of 0.21:1 was within the criteria range (0.01:1 to 0.54:1) specified in the SLMP (Tables 1 and 5). The average ratio from 1990 to 2009 was 0.10:1 and the average ratio from 1988 to 1989 was 0.31:1 (pre-stocking mean). The 2010 *Diaptomus* to *Cyclops* ratio was the highest since 1991.

Mean Cladoceran Biomass

The 2010 seasonal average cladoceran density in Spiridon Lake was 891 No./m^3 with an average biomass of 2.8 mg/m^3, which was within the SLMP criteria range of 2.6 to 6.8 mg/m^3 (Tables 1, 4, and 6). The 2010 average biomass of 2.8 mg/m^3 was below the 1990 to 2009 average cladoceran biomass of 5.6 mg/m^3 and the 2010 density (891 No./m^3) was below the 1990 to 2009 average of 1,573 No./m^3. The 2010 values were the lowest since 1999 (Tables 4 and 6).

Bosmina to Daphnia Density Ratio

The *Bosmina* to *Daphnia* ratio of 3.28:1 was outside of the criteria range (0.22:1 to 1.73:1) specified in the SLMP (Tables 1 and 6). The average ratio from 1990 to 2009 was 1.04:1 and the average ratio from 1988 to 1989 was 1.80:1 (pre-stocking mean). The low density and biomass of *Daphnia* observed the last two years contributed to the highest *Bosmina* to *Daphnia* ratios ever observed (Table 6).

Mean Cladoceran (Bosmina) Size

In 2010, the cladoceran *Bosmina* averaged 0.47 mm in length, which was just below the criteria (≥0.51 mm) specified in the SLMP (Tables 1 and 7). This compares to the average *Bosmina* size from 1990 to 2009 of 0.53 mm and the average pre-stocking (1988 to 1989) size of 0.58 mm. In the two previous years (2008 and 2009), the cladoceran *Bosmina* average length met the criteria specified in the SLMP.

SPIRIDON LAKE SPECIAL USE PERMIT MONITORING

Stocking

Approximately 3,006,265 (2,817,803 at 0.4 g; 188,462 at 0.3 g) sockeye salmon fry were stocked into Spiridon Lake on 26–27 June 2010 by fixed-winged aircraft (Table 8). The average total sockeye salmon release into Spiridon Lake from 1991 to 2009 was 3,091,203 (Table 8).

Smolt Monitoring

Approximately 669,343 live sockeye salmon smolt emigrated from Spiridon Lake from 10 May to 10 July in 2010 (Table 9; Appendix B1). The average emigration from 1992 to 2009 was 788,468 live sockeye salmon smolt (Table 9). Smolt mortality in the trapping/bypass system was higher than the mean from 1992 through 2009 (2.0%), at 5.7% in 2010 (Table 9). The increased mortality in 2010 arose, primarily, from extraordinarily high stream flow.

The age composition of the 2010 Spiridon Lake outmigration was predominately age-1. (79.1%) and the remaining sockeye salmon smolt emigrating were age-2. (20.9%; Table 9). This was similar to the long-term average (1992 to 2009) age composition of sockeye salmon smolt, which was 76.8% age-1., followed by 23.0% age-2., and 0.2% age-3. smolt. The 2010 age structure was vastly different from 2008 and 2009, when proportions of age-2. smolt were unusually high (Table 9).

In 2010, age-1. sockeye salmon smolt captured in the Spiridon Lake trap averaged 114 mm in length and weighed 11.8 g; age-2. smolt captured in the trap averaged 142 mm in length and weighed 23.6 g (Table 10). Age-3. sockeye salmon smolt were not captured in the trap in 2010. The long-term average (1992 to 2009) length and weight of age-1. sockeye salmon smolt captured in the trap was 108 mm and 10.7 g and the average length and weight of age-2. smolt was 148 mm and 28.9 g.

In 2010, the average condition (K) of age-1. sockeye salmon smolt captured in the Spiridon Lake trap was 0.79 and age-2. sockeye salmon smolt captured in the trap averaged 0.81. This is similar to the historical average (1992 to 2009) condition (K) for both age-1. and age-2. of 0.81 (Table 10).

The 2010 outmigration was comprised of age-1. sockeye salmon smolt stocked in 2009 and age-2. smolt stocked in 2008 (Appendix B3). Of the 1,475,160 smolt stocked in 2009, 561,637 (38.1%) survived and outmigrated as age-1.'s; of the 1,049,809 smolt stocked in 2008, 148,048

(14.1%) survived and outmigrated as age-2.'s. Over the long term (1991 to 2005), an average of 24.2% survived and outmigrated as age-1. smolt and 5.6% were age-2. smolt. The number of age-2. sockeye salmon smolt outmigrating from juveniles stocked in 2006 through 2008 surpassed the number of age-1. smolt outmigrating from 2006 to 2008.

Harvest Monitoring

In 2010, the commercial harvest monitoring camp in Telrod Cove was occupied from 20 June to 4 August. The harvest within SBSHA began with a cost recovery from 22 June to 30 June 2010 with a harvest of 10,840 sockeye salmon (Table 12). Common property commercial salmon harvests in the SBSHA occurred from 2 July through 11 August in 2010 (Table 11). Approximately 100,727 sockeye salmon, 36 coho salmon *O. kisutch*, 53,516 pink salmon, and 5,887 chum salmon *O. keta* were harvested in Telrod Cove between the common property commercial harvest and cost recovery (Jackson et al. 2010; Tables 11 and 12). The 2010 SBSHA harvest was slightly lower than the 1994 to 2009 average harvest for sockeye (108,612), coho (1,439), pink (67,057) and chum (6,079).

From 21 June to 2 August a total of 1,370 ASL samples were aged from 1,400 samples collected in the SBSHA (Figure 1; Table 13). Age-2.2 sockeye salmon comprised the majority (55.0%) of the SBSHA harvest in 2010, while the age-1.3 fish comprised 19.8%, the age-1.2 fish comprised 17.4%, and the age-2.3 fish comprised 6.7% of the harvest (Table 13). Historically (1994 to 2009), the age-1.2 component has averaged slightly more than half of the Telrod Cove sockeye salmon harvest (52.2%), while the age-1.3 component has averaged 26.8%, the age-2.2 component has averaged 15.8%, and age-2.3 comprised 2.5%. In 2010, no ASL samples were collected from salmon set net sites in statistical area 254-40.

Escapement Monitoring

Spiridon River

The indexed peak pink salmon escapement count into the Spiridon River (stream #254-401; not a part of Spiridon Lake Drainage; Figure 1) was estimated by aerial survey to be 1,000 fish on 30 August (Table 14). An indexed peak chum salmon escapement count of 10,700 fish was estimated by aerial survey (30 August). Both pink and chum survey numbers were likely underestimated because of poor stream clarity (Joe Dinnocenzo, Fishery Biologist, ADF&G, Kodiak, personal communication). No coho salmon were observed in the surveys.

NON-CRITERION MONITORING (SLMP/SUP)

Lake Temperature

Mean surface temperatures for Spiridon Lake were 3.9°C in the spring, 12.2°C in the summer, and 12.9°C in the fall (Appendix A5). Historic mean temperatures (1993 – 2009) were 6.1°C in the spring, 13.8°C in the summer, and 10.3°C in the fall.

Mean bottom temperatures for Spiridon Lake were 3.0°C in the spring, 5.3°C in the summer, and 5.5°C in the fall (Appendix A5). Historic mean temperatures (1993 – 2009) were 3.9°C in the spring, 4.9°C in the summer, and 5.6°C in the fall.

Spring and summer surface temperatures were lower in 2010 than in 2009 (Appendix A5). Spring and fall bottom temperatures were lower in 2010 than in 2009. Summer and fall bottom temperatures were greater in 2010. Spiridon Lake was well mixed in May of 2010 and began stratifying by June (Figure 4). The May temperature in 2010 was the lowest documented from 1993 to 2010 (Appendix A6).

Phytoplankton Biomass

Four years of phytoplankton biomass data (2004–2006, and 2010) has been analyzed in Spiridon Lake. The 2010 phytoplankton biomass at the 1-m depth averaged 67.2 mg/m^3 (Table 15). The biomass in 2010 was below the three year average (2004–2006; 87.9 mg/m^3) but greater than the average biomass in 2005 and 2006. Within this four year data set, the 2010 phytoplankton biomass was most similar to that found in 2004. Phytoplankton were composed predominately of Bacillariophyta (diatoms) in 2004 and 2010 and Chrysophyta (golden algae) in 2005 and 2006. Mean biomass was greater in 2004 and 2010 than in 2005 and 2006.

Total Zooplankton Abundance

The 2010 seasonal mean zooplankton density in Spiridon Lake was 2,438 No./m^3 and the biomass was 7.2 mg/m^3 (Table 4; Figure 3). The 2010 total zooplankton density and biomass were well below the average values from 1990 to 2009 (5,728 No./m^3; 14.6 mg/m^3; Table 4). The 2010 cladoceran to copepod biomass ratio was 0.66:1 and the cladoceran to copepod density ratio was 0.58:1 (Table 4). The average (1990 to 2009) cladoceran to copepod biomass ratio was 0.63:1 and the cladoceran to copepod density ratio was 0.38:1 (Table 4).

Escapement Monitoring

Telrod Creek

Although no longer required as part of the SUP, a stream survey of Telrod Creek was conducted downstream of the terminal falls on 2 August 2010. A total of 200 sockeye salmon and no pink salmon were observed (Table 16).

FACTORS RELATED TO SMOLT SURVIVAL, AGE, AND GROWTH

Juvenile Sockeye Salmon Survival

Spiridon Lake sockeye salmon juvenile release to smolt survival averaged 29.9% from 1991 through 2005, varying from a low of 8.0% to a high of 52.3% (Appendix B3). During these same years smolt to adult survival averaged 30.3%, varying from a low of 18.4% to a high of 43.4%. Total survival (juvenile to adult) averaged 8.7%, varying from a low of 2.4% to a high of 14.4%. Survival estimates for sockeye salmon stocking after 2006 cannot be fully addressed until future outmigrations are fully recruited.

Brood Stock

Survival of sockeye salmon stocked into Spiridon Lake varied by the brood stock used. Survival of Upper Station Lake sockeye salmon in Spiridon Lake (1991–1994, 1996–1997) had a lower survival rate compared to the Saltery Lake stock (1995,1998–2005; Appendix B3). Juvenile to smolt sockeye salmon survival for Upper Station Lake stock averaged 20.8%, while Saltery Lake stock averaged 35.9%. Smolt to adult sockeye salmon survival for Upper Station Lake stock averaged 29.7%, while Saltery Lake stock averaged 30.7%. Juvenile to adult sockeye salmon survival for Upper Station Lake stock averaged 5.7%, while Saltery Lake stock averaged 10.8%.

Lake Temperature

Smolt age composition seemed to change with July lake temperature. When July lake temperatures increased, there was a statistically significant rise in the proportion of stocked juveniles that emigrated at age-1. ($p < 0.05$; adjusted R^2 0.33246; $p = 0.02294$)). The segment of stocked juveniles that emigrated at age-2. was elevated in years with lower July lake temperatures, but the increase was not statistically significant ($p > 0.05$; adjusted R^2 0.22128; $p = 0.06967$).

Zooplankton

Smolt survival appeared to vary with changes in three zooplankton genus/species. In the first of these, smolt increased in survival when the size of *Cyclops* decreased (adjusted R^2 0.26311; $p = 0.01715$). Initially, smolt survival did not vary with *Cyclops* density and biomass. Yet, when years stocked with pre-smolt were excluded, the survival of age-1. sockeye salmon smolt increased when *Cyclops* density increased (adjusted R^2 0.36566; $p = 0.03766$). In the second of these, survival of age-1. sockeye salmon smolt increased when the density of *Bosmina* increased (adjusted R^2 0.31344; $p = 0.00922$); survival did not vary with body size ($p > 0.05$). In the third of these, the survival of age-2. sockeye salmon smolt increased when the lagged biomass of *Daphnia* increased (adjusted R^2 0.45818; $p = 0.01324$), when years stocked with pre-smolt were excluded. Data from years when pre-smolt were stocked was excluded in some circumstances because it appears that changes in zooplankton may vary differently when stocked with fry.

Juvenile Sockeye Salmon Age and Growth

Lake Temperature

Lake temperatures in most months showed little correlation with sockeye salmon growth. However, July was the most influential month; age-1. and age-2. sockeye salmon smolt length and weight increased when surface temperatures increased (age-2. smolt length, adjusted R^2 0.16868; $p = 0.09083$).

Zooplankton

Juvenile sockeye salmon growth varied with zooplankton abundance, size, and genus/species. In the first of these, body condition of age-1. sockeye salmon smolt increased when the body length of *Cyclops* increased (adjusted R^2 0.18018; $p = 0.03981$). Length and weight of age-1. sockeye salmon smolt did not vary with *Cyclops* body length (weight, adjusted R^2 0.0684; $p = 0.14598$). In the second, the weight of age-1. sockeye salmon smolt increased when the density of *Bosmina* increased (adjusted R^2 0.1718; $p = 0.08862$), excluding years when pre-smolt were stocked. In the third, both the length and weight of age-1. sockeye salmon smolt increased when *Diaptomus* density increased (adjusted R^2 0.4244; $p = 0.0015$). Correspondingly, when the density of *Diaptomus* increased, the condition of age-1. smolt increased (adjusted R^2 0.30351; $p = 0.00852$). When the density of *Diaptomus* increased, the weight of age-2. smolt appears to have increased (adjusted R^2 0.15664; $p = 0.05256$). Alternately, the length of *Diaptomus* showed no correlation with the condition of smolt (age-1. weight, adjusted R^2 0.02628; $p = 0.2395$).

Zooplankton Size and Abundance

Lake Temperature

Lake temperatures were associated with zooplankton size and abundance in May, July, and August, but not other months.

Density of the copepod *Cyclops* revealed a somewhat significant relationship with May surface temperature, with lake temperature accounting for just over 38% of the variation in *Cyclops* density (adjusted R2 0.3854; p = 0.0061; Figure 5). The size of *Cyclops* was not associated with May lake temperatures.

Lake temperature in July was significantly associated with *Bosmina* density (adjusted R^2 0.5923; p = 0.00127; Figure 6). *Bosmina* biomass also exhibited a significant relationship with lake temperature in July (adjusted R^2 0.50474; p = 0.00391). The size of *Bosmina* showed no relationship with July lake temperature. The density of *Holopedium* also exhibited a significant relationship with July lake surface temperatures (adjusted R^2 0.35148, p = 0.01926). There is a correlation between *Cyclops* size and July surface temperatures, possibly related to the relationship *Cyclops* size has with *Bosmina* abundance (R^2 0.2088).

Bosmina abundance was also significantly associated with August lake temperature (adjusted R^2 0.31283; p = 0.01149). The density of *Daphnia* increased when August surface lake temperature increased, with lake temperature accounting for nearly 38% of the variation in *Daphnia* density (adjusted R^2 0.37994; p = 0.00499).

Zooplankton grazing

Some species of zooplankton commonly graze (feed) upon other zooplankton species. Further, when planktivorous fish, such as large juvenile sockeye salmon, predominate, the average length of many zooplankton species tends to decrease as predation increases. Similarly, if predatory zooplankton predominates (such as large *Cyclops*), the average length of many zooplankton species tends to increase when predation increases because they prey upon smaller individuals (Carpenter et al. 1985).

In Spiridon Lake, the abundance of *Cyclops* and the size of *Bosmina* appear closely intertwined. As the biomass of *Cyclops* increased, the size of *Bosmina* increased (adjusted R^2 0.34203; p = 0.004). This relationship with *Bosmina* size diminished significantly for the density and size of *Cyclops* (*Cyclops* density, adjusted R^2 0.12886; p = 0.06666). Without pre-smolt stocking, the size of *Bosmina* increased as the size of *Cyclops* increased (adjusted R^2 0.35592; p = 0.03096). Additionally, without pre-smolt stocking the relationship with the size of *Bosmina* and the density of *Cyclops* diminished significantly (R^2 0.0158). Further, the length of *Bosmina* averaged 0.55 mm before pre-smolt stocking with high *Cyclops* abundance, 0.49 mm during pre-smolt stocking with low *Cyclops* abundance, and 0.55 mm after pre-smolt stocking with high *Cyclops* abundance (Tables 7 and 8).

Juvenile sockeye salmon grazing

Grazing by juvenile sockeye salmon in Spiridon Lake influenced the size of two zooplankton genus/species. The first, used the lagged length (one year lag) of *Holopedium* and was moderately influenced by the sockeye salmon smolt outmigration, with the length of *Holopedium* decreasing when more smolt outmigrate (adjusted R^2 0.28965; p = 0.01022). Secondarily, *Cyclops* were only revealed when considering years stocked with pre-smolt. During years stocked with pre-smolt, the length of *Cyclops* decreased significantly when pre-smolt stocking was increased (adjusted R^2 0.57078; p = 0.05055).

DISCUSSION

Relationships surrounding "whole lake" interactions and salmon smolt production are complex. Spiridon Lake, as a barren system, provides a unique opportunity to explore some of these complex interactions. Limnological data has been collected in Spiridon Lake yearly since 1988 providing considerable data for exploration into these interactions. As a stocked lake, the juvenile salmon density, size, and age at stocking into Spiridon Lake are controlled. The trap system captures nearly all of the outmigrating smolt, providing reliable estimates of subsequent smolt survival, size, weight, and condition. Further, the corresponding adult returns and age structure are estimated annually.

Seasonal mean water chemistry and nutrient criterion measurements in Spiridon Lake have fluctuated year to year but concentrations have remained relatively constant over the 23-year data set (1988–2010). Despite natural lake fluctuations, the seasonal means for these criteria measured are within ranges found in oligotrophic lakes.

Primary production in Spiridon Lake has been measured by determining the phytoplankton standing crop (chlorophyll-*a*) during the ice free season. Historically, Spiridon Lake chlorophyll-*a* concentrations have remained relatively stable and within ranges for oligotrophic lakes in Alaska (Schrof and Honnold 2003). Recently, evaluation of primary production has been expanded with the analysis of phytoplankton taxon composition (2004–2006 and 2010). Phytoplankton biomass in Spiridon Lake appears to be remarkably variable between years, while specific taxon seems to be comprised of mainly two phylum, diatoms and golden-brown algae. Possibly, phytoplankton biomass may be greater when comprised of mainly diatoms (Table 15).

Water temperatures are commonly known to play a key role in primary production (Sommer and Lengfellner 2008; Shutter and Ing 1997). Increases in lake temperatures typically contribute to an increase in production at each trophic level. An increase in phytoplankton abundance provides for a potential increase in zooplankton abundance and juvenile sockeye salmon abundance and fitness. In Spiridon Lake, increased lake temperatures in May were followed by an increased abundance of *Cyclops*. Increased lake temperatures in July were followed by an increase in the abundance of cladocerans and likely resulted in an increase in the growth and survival of juvenile sockeye salmon, promoting an earlier smolt outmigration. Increased lake temperatures in August were followed by an increase in the abundance of some cladocerans.

The response zooplankton exhibit to juvenile sockeye salmon stocking in barren lakes can be quite variable. In general, planktivores tend to select the largest prey they can consume, in many cases reducing zooplankton body size (Kyle et al. 1996; Carpenter et al. 1985). Populations and sizes of planktivores fluctuate, altering the length of zooplankton prey. When planktivorous fish predominate, such as large juvenile sockeye salmon, the average length of many zooplankton species tends to decrease as predation increases. Conversely, if predatory zooplankton predominate, such as large *Cyclops*, the average length of many zooplankton species tends to increase when predation increases because they prey upon smaller individuals (Carpenter et al. 1985).

Sweetman (2001; Sweetman and Finney 2003) hypothesized that the predatory zooplankton *Cyclops* selectively feeds on *Bosmina* in many Alaska lakes. This selective feeding was demonstrated by *Cyclops* cropping the smaller *Bosmina,* while the length of *Bosmina* remaining in the lake increased (those too large to feed on). This occurrence, Sweetman (2001) postulated, was why larger *Bosmina* occurred in lakes with a higher density of *Cyclops*. This hypothesized predatory relationship likely exists in Spiridon Lake but is not evident when juvenile sockeye salmon are stocked as pre-smolt. This predatory shift likely results from the pre-smolt tendency to select larger prey (Carpenter et al. 1985). The increase in the size of *Bosmina* found in Spiridon Lake when *Cyclops* density increased follows Sweetman (2001) and Sweetman and Finney's (2003) findings. Further, the potential linkage between *Cyclops* size and *Bosmina* size only expressing itself when pre-smolt stocking occurs corroborates Sweetman (2001) and Sweetman and Finney's (2003) conclusions.

Sockeye salmon have been stocked at three life stages in Spiridon Lake; fry, fingerling, and pre-smolt (Table 8). Stocking strategy from 1991 to 2001 and from 2008 to 2010 consisted of fry and/or fry and fingerling releases. During these years, stocking releases averaged over 3.5 million sockeye salmon and zooplankton abundance remained fairly consistent, averaging 5,939 No./m^3 (Tables 4 and 8; Appendix A4). Juvenile releases from 2002 to 2007 consisted of pre-smolt releases in conjunction with fry or fingerling releases. During these years, stocking releases averaged nearly 1.9 million, zooplankton abundance declined, averaging 4,406 No./m^3, and cladocerans became the predominate zooplankton (Tables 4 and 8; Appendix A4).

CONCLUSIONS

Spiridon Lake has supported a reasonably steady level of salmon stocking and a fairly robust zooplankton population throughout most of the enhancement project (1990–2010). Recent fluctuations in zooplankton abundance and temperatures have resulted in fluctuating juvenile stocking levels, but more robust outmigrating smolt. Commercial harvest is projected to be below average but may improve in the near future in response to increased stocking density.

Based on previous studies and the findings within this report, lake temperature appears to be an important influence on primary and secondary production. Lake water temperatures were well below average in 2010 and combined with increased stocking densities, likely contributed to the below average zooplankton abundance. Even with a decrease in the abundance of zooplankton in 2010, the zooplankton species composition returned to copepod dominance and the *Diaptomus:Cyclops* density ratio improved greatly. On the other hand, the abundance of *Daphnia* and the size of *Bosmina* were below average.

The 2010 smolt outmigration returned to an age-1. dominance and survivals were above average. Reflective of the improved rearing conditions of 2009, smolt outmigrated at a larger size than those in 2009. The rearing conditions in 2010 were not as favorable for smolt growth and will likely result in a reduction in growth and survival in the outmigration in 2011.

OUTLOOK FOR 2011

In an effort to maintain sufficient zooplankton production, ADF&G recommended sockeye salmon stocking slightly below average historical levels. These stocking levels should maintain reasonable grazing pressure on the zooplankton community and allow for improvements in *Daphnia* abundance and average *Bosmina* length, while maintaining healthy juvenile sockeye salmon growth.

The 2011 projected release of juvenile sockeye salmon into Spiridon Lake will be decreased to approximately 2.0 million, 0.4 g fry (Finkle and Byrne 2010). While it is not definitive that pre-smolt stocking was detrimental to zooplankton abundance, conservation is warranted and only stocking of fry was recommended. In 2011, the forecasted harvest for Spiridon Lake sockeye salmon is 133,000 (Birch Foster, Biologist, ADF&G, Kodiak, personal communication).

Project activities in 2011 at the Spiridon Lake smolt site (Telrod Creek) are expected to be similar to the 2010 field season.

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REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 1994. Alaska sockeye salmon culture manual. Special Fisheries Report No. 6, Juneau.

AWWA (American Water Works Association). 1998. Standard methods for the examination of water and wastewater, 20th Edition., Washington D.C.

Carpenter, S. R., J. F. Kitchell, and J. R. Hodgson. 1985. Cascading Trophic Interactions and Lake Productivity. American Institute of Biological Sciences Vol. 35 No. 10.

Chatto, D. T. 2000. Spiridon Lake enhancement project management plan. US Fish and Wildlife Service, Kodiak National Wildlife Refuge, Kodiak.

Edmondson, W. T. 1959. Fresh-water biology. Second edition. John Wiley and sons, New York.

Eisenreich, S. J., R. T. Bannerman, and D. E. Armstrong. 1975. A simplified phosphorous analysis technique. Environ. Letters 9:43-53.

Finkle, H. and G. Byrne. 2010. Pillar Creek Hatchery annual management plan, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 10-35, Anchorage.

Foster, B. M., R. T. Baer, S. Thomsen, and D. Ruhl. 2010a. Spiridon Lake sockeye salmon smolt and commercial fishery monitoring project operational plan, 2010. [*In*] Salmon research operational plans for the Kodiak Area, 2010. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K10-03, Kodiak.

Foster, B. M., R. T. Baer, S. Thomsen, and D. Ruhl. 2010b. Near Island limnology laboratory and Kodiak Archipelago lake assessment project operational plan, 2010. [*In*] Salmon research operational plans for the Kodiak Area, 2010. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K10-03, Kodiak.

Honnold, S. G. 1997. The results of sockeye salmon *Oncorhynchus nerka* stocking into Spiridon Lake on the Kodiak National Wildlife Refuge: juvenile and adult production, commercial harvest, and ecosystem effects, 1987-1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K01-32, Kodiak.

Jackson, J., J. Dinnocenzo, and G. Spalinger. 2010. Kodiak Management Area commercial salmon fishery annual management report, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 10-47, Anchorage.

Koenings, J. P., J. A. Edmundson, G. B. Kyle, and J. M. Edmundson. 1987. Limnology field and laboratory manual: methods for assessing aquatic production. Alaska Department of Fish and Game, FRED Division Report Series 71, Juneau.

Kyle, G. B. 1996. Stocking sockeye salmon *Oncorhynchus nerka* in barren lakes of Alaska: effects on the macrozooplankton community. Fisheries Research 28:29-44.

REFERENCES CITED (Continued)

Schrof, S., and S. Honnold. 2 003. Salmon enhancement, rehabilitation, evaluation, and monitoring efforts conducted in the Kodiak management area through 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K03-41, Kodiak.

Shutter. B. J. and K. K. Ing. 1997. Factors affecting the production of zooplankton in lakes. Canadian Journal of Aquatic Science Volume 54.

Sommer U. and K. Lengfellner. 2008. Climate change and the timing, magnitude and composition of the phytoplankton spring bloom. Global Change Biology (2008) 14: 1199-1208.

Sweetman, J. N. 2001. Factors influencing zooplankton populations in Alaskan sockeye salmon (*Oncorhynchus nerka*) nursery lakes; insights from limnological and paleolimnological analyses. Master of Science Thesis, University of Alaska, Fairbanks.

Sweetman, J. N. and B. P. Finney. 2003. Differential responses of zooplankton populations (*Bosmina longirostris*) to fish predation and nutrient-loading in an introduced and a natural sockeye salmon nursery lake on Kodiak Island, Alaska, USA. Journal of Paleolimnology 30:183-193.

Thomsen, S. E. 2010. A compilation of the 2009 Spiridon Lake sockeye salmon enhancement project results: A report to the Kodiak National Wildlife Refuge, Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K10-37, Kodiak.

Thomsen, S. E. 2008. Kodiak Island Lake Assessment/Limnology Project and Laboratory Analysis Operational Plan, Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K08-4, Kodiak.

Thorp, J. H., and Covich, A. P. 2001. Ecology and classification of North American freshwater invertebrates. Second edition. Academic Press.

USFWS. 1991. E nvironmental assessment for the introduction of sockeye salmon into Spiridon Lake on the Kodiak National Wildlife Refuge, U.S. Fish and Wildlife Service. Kodiak, Alaska.

Wetzel, R. G. 1983. Limnology. New York. CBS College Publishing.

TABLES AND FIGURES

Table 1.–Spiridon Lake limnological and fishery monitoring criteria specified in the Spiridon Lake Management Plan (SLMP), and the 2010 results.

	SLMP monitoring criteria	2010 results
Limnology Monitoring		
Mean Total Nitrogen : Total Phosphorous Molar Ratio	148 – 273	287
Mean Total Ammonia (μg/ L)	1.6 – 11.2	4.2
Mean Chlorophyll *a* (Chl *a*) (μg/L)	0.1 – 1.0	0.4
Diaptomus : *Cyclops* Ratio	0.01 – 0.54	0.21
Mean Copepod Biomass (mg/m^3)	3.5 – 21.7	4.3
Bosmina : *Daphnia* Ratio	0.22 – 1.73	3.28
Mean Cladoceran Biomass (mg/m^3)	2.6 – 6.8	2.8
Cladoceran (*Bosmina*) average size (mm)	≥ 0.51	0.47
Stocking		
Sockeye	–[a]	3,006,265
Smolt Monitoring		
Sockeye smolt outmigration estimate	–[a]	669,343
Commercial Harvest from the SBSHA [b]	–[a]	
Telrod Cove (254-50)	–[a]	
Sockeye [c]	–[a]	100,727
Coho	–[a]	36
Pink	–[a]	53,516
Chum	–[a]	5,887
Escapement Monitoring	–[a]	
Spiridon River (254-401)	–[a]	
Pink (escapement range: 15,000–45,000)	–[a]	1,000
Chum (escapement range: 10,000–30,000)	–[a]	10,700
Coho (escapement range: 4,000–12,000)	–[a]	0

[a] Not a specified criteria in the SLMP

[b] Spiridon Bay Special Harvest Area

[c] Reported harvest includes commercially harvested “home pack”.

Table 2.–Seasonal mean total Kjeldahl nitrogen (TKN), nitrate+nitrite (NO_3+NO_2), total phosphorus (TP) concentrations, and total nitrogen to phosphorus ratio by weight (TN:TP) from the epilimnion (1 m) and hypolimnion (>25 m) of Spiridon Lake, 1988–2010.

			TKN	(NO_3+NO_2)	TP	TN:TP	Mean TN:TP Ratio	
Year	Depth	Station	(µg/L)	(µg/L)	(µg/L)	Ratio	Epilimnion	Hypolimnion
1988	Epilimnion	1	102.8	220.5	3.8	187		
1988	Hypolimnion	1	94.9	256.9	3.8	205		
1988	Epilimnion	2	100.5	221.3	3.5	204		
1988	Hypolimnion	2	91.4	236.2	4.0	181	195	193
1989	Epilimnion	1	103.4	207.1	3.6	189		
1989	Hypolimnion	1	97.9	242.8	4.2	179		
1989	Epilimnion	2	114.8	197.9	6.1	114		
1989	Hypolimnion	2	104.0	209.8	7.3	95	151	137
1990	Epilimnion	1	92.5	203.4	3.5	188		
1990	Hypolimnion	1	85.3	228.5	3.0	233		
1990	Epilimnion	2	83.2	185.0	2.4	245		
1990	Hypolimnion	2	87.7	187.3	2.5	244	217	238
1991	Epilimnion	1	93.7	234.0	4.9	148		
1991	Hypolimnion	1	87.5	265.1	5.2	150		
1991	Epilimnion	2	91.8	237.0	3.6	201		
1991	Hypolimnion	2	88.6	267.7	3.8	209	175	180
1992	Epilimnion	1	89.6	239.5	3.7	196		
1992	Hypolimnion	1	87.0	258.7	4.9	158		
1992	Epilimnion	2	98.4	235.2	3.6	207		
1992	Hypolimnion	2	83.2	273.4	4.5	175	201	166
1993	Epilimnion	1	93.6	231.6	2.7	267		
1993	Hypolimnion	1	90.7	240.2	3.0	248		
1993	Epilimnion	2	97.0	230.3	2.9	253		
1993	Hypolimnion	2	85.4	247.7	2.5	293	260	271
1994	Epilimnion	1	101.8	204.3	3.2	212		
1994	Hypolimnion	1	97.5	218.1	3.9	178		
1994	Epilimnion	2	105.7	202.1	2.8	245		
1994	Hypolimnion	2	105.6	225.7	3.3	219	228	199
1995	Epilimnion	1	108.8	203.1	3.4	203		
1995	Hypolimnion	1	105.6	241.6	3.4	225		
1995	Epilimnion	2	125.2	213.4	3.9	194		
1995	Hypolimnion	2	108.2	243.1	3.2	244	199	235

-continued-

Table 2.–Page 2 of 3.

Year	Depth	Station	TKN (µg/L)	(NO_3+NO_2) (µg/L)	TP (µg/L)	TN:TP Ratio	Mean TN:TP Ratio Epilimnion	Mean TN:TP Ratio Hypolimnion
1996	Epilimnion	1	113.4	183.6	2.7	242		
1996	Hypolimnion	1	90.5	210.8	3.0	222		
1996	Epilimnion	2	105.5	180.2	2.7	236		
1996	Hypolimnion	2	101.1	217.9	4.4	162	239	192
1997	Epilimnion	1	103.6	147.4	3.0	184		
1997	Hypolimnion	1	90.5	191.0	2.8	223		
1997	Epilimnion	2	106.1	168.2	3.1	198		
1997	Hypolimnion	2	107.4	188.3	3.8	171	191	197
1998	Epilimnion	1	138.3	121.5	4.8	120		
1998	Hypolimnion	1	118.4	174.4	4.0	162		
1998	Epilimnion	2	124.6	148.3	3.9	155		
1998	Hypolimnion	2	122.9	171.9	4.0	163	137	163
1999	Epilimnion	1	93.0	188.0	4.0	155		
1999	Hypolimnion	1	92.0	211.4	3.2	213		
1999	Epilimnion	2	103.5	193.4	2.7	240		
1999	Hypolimnion	2	87.9	208.1	3.0	221	197	217
2000	Epilimnion	1	ND	195.5	7.0	ND		
2000	Epilimnion	2	ND	184.0	6.1	ND	ND	ND
2001	Epilimnion	1	101.2	193.8	4.9	133		
2001	Epilimnion	2	ND	189.2	6.7	ND	133	ND
2002	Epilimnion	1	96.7	136.5	3.3	156		
2002	Epilimnion	2	ND	135.0	4.0	ND	156	ND
2003	Epilimnion	1	100.3	203.3	5.7	118		
2003	Epilimnion	2	ND	201.3	3.5	ND	118	ND
2004	Epilimnion	1	98.7	197.3	4.4	149		
2004	Hypolimnion	1	109.9	197.7	4.8	142		
2004	Epilimnion	2	ND	186.4	4.6	ND		
2004	Hypolimnion	2	ND	200.3	10.0	ND	149	142
2005	Epilimnion	1	147.4	139.5	2.7	235		
2005	Hypolimnion	1	40.1	163.7	3.9	116		
2005	Epilimnion	2	ND	142.5	4.1	ND		
2005	Hypolimnion	2	139.8	169.7	5.1	134	235	125

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Year	Depth	Station	TKN (µg/L)	(NO_3+NO_2) (µg/L)	TP (µg/L)	TN:TP Ratio	Mean TN:TP Ratio Epilimnion	Mean TN:TP Ratio Hypolimnion
2006	Epilimnion	1	255.9	182.7	1.4	694		
2006	Hypolimnion	1	183.1	190.4	1.5	551		
2006	Epilimnion	2	ND	181.8	1.7	ND		
2006	Hypolimnion	2	ND	197.5	2.4	ND	694	551
2007	Epilimnion	1	127.8	171.0	2.3	285		
2007	Hypolimnion	1	108.8	192.8	2.2	304		
2007	Epilimnion	2	ND	165.6	2.1	ND		
2007	Hypolimnion	2	ND	192.0	2.3	ND	285	304
2008	Epilimnion	1	105.8	186.6	2.1	308		
2008	Hypolimnion	1	ND	208.3	2.2	ND		
2008	Epilimnion	2	76.0	178.4	2.7	209		
2008	Hypolimnion	2	ND	183.6	19.3	ND	258	ND
2009	Epilimnion	1	130.0	185.8	3.0	233		
2009	Hypolimnion	1	ND	199.3	4.2	ND		
2009	Epilimnion	2	103.0	193.2	2.5	262		
2009	Hypolimnion	2	ND	213.7	3.1	ND	248	ND
2010	Epilimnion	1	87.6	179.5	1.8	329		
2010	Hypolimnion	1	ND	187.8	2.2	ND		
2010	Epilimnion	2	108.2	180.8	2.6	246		
2010	Hypolimnion	2	ND	199.0	2.7	ND	287	ND
Epilimnion mean (1988–1989)							173	165
Epilimnion mean (1990–2009)							227	227

Table 3.–Summary of seasonal mean epilimnion and hypolimnion, nutrient and algal pigment concentrations by station for Spiridon Lake, 1988–2010.

Year	Station	Depth (m)	Total-P (µg/L)	SD	Total filterable-P (µg/L)	SD	Filterable reactive-P (µg/L)	SD	Total Kjeldahl nitrogen (µg/L)	SD	Ammonia (µg/L)	SD	Nitrate+nitrite (µg/L)	SD	Chlorophyll *a* (µg/L)	SD
1988	1	1	3.8	1.4	3.0	1.1	2.5	1.2	102.8	11.4	9.9	2.7	220.5	26.0	0.45	0.09
	1	50	3.8	0.6	2.2	0.6	1.7	0.5	94.9	9.0	11.2	5.5	256.9	9.6	0.16	0.06
	2	1	3.5	0.1	2.0	0.6	1.8	0.3	100.5	11.3	7.8	6.6	221.3	11.1	0.40	0.10
	2	50	4.0	0.6	1.9	0.6	1.8	0.5	91.4	9.9	8.6	4.4	236.2	27.5	0.29	0.12
1989	1	1	3.6	0.7	3.7	1.9	3.0	2.2	103.4	7.6	8.5	2.5	207.1	35.4	0.19	0.11
	1	50	4.2	1.0	3.2	1.2	2.4	0.4	97.9	18.6	11.5	7.3	242.8	54.9	0.32	0.18
	2	1	6.1	3.7	2.7	1.0	2.5	0.4	114.8	45.7	9.5	5.2	197.9	61.9	0.18	0.13
	2	50	7.3	7.8	2.7	0.7	2.7	0.7	104.0	40.1	12.5	11.0	209.8	50.4	0.37	0.28
1990	1	1	3.5	1.8	2.4	0.6	2.0	0.8	92.5	16.5	4.9	2.0	203.4	36.8	0.23	0.11
	1	50	3.0	0.7	2.8	0.5	2.0	0.6	85.3	10.9	6.3	2.5	228.5	24.8	0.34	0.21
	2	1	2.4	0.6	4.1	3.2	3.3	2.4	83.2	6.4	4.7	1.7	185.0	79.4	0.24	0.09
	2	50	2.5	0.8	2.8	1.1	2.9	1.9	87.7	12.3	6.6	2.8	187.3	80.1	0.24	0.12
1991	1	1	4.9	5.9	2.8	0.8	2.6	0.9	93.7	7.3	7.6	4.4	234.0	38.1	0.38	0.14
	1	50	5.2	3.7	3.3	2.0	2.8	1.4	87.5	12.9	9.4	4.8	265.1	20.9	0.20	0.09
	2	1	3.6	0.8	4.8	3.3	4.6	3.3	91.8	8.6	8.2	4.5	237.0	29.6	0.35	0.12
	2	50	3.8	1.5	3.6	3.3	3.4	3.2	88.6	7.4	11.3	5.8	267.7	7.7	0.25	0.14
1992	1	1	3.7	0.6	2.1	0.7	1.5	0.5	89.6	10.1	1.5	0.8	239.5	12.3	0.27	0.15
	1	50	4.9	1.4	4.2	3.1	3.7	3.0	87.0	8.0	4.6	3.3	258.7	16.9	0.22	0.07
	2	1	3.6	0.3	2.6	1.4	2.4	1.4	98.4	18.2	1.7	0.6	235.2	25.9	0.27	0.21
	2	50	4.5	0.8	3.1	2.8	2.0	1.1	83.2	24.8	5.3	3.7	273.4	7.7	0.23	0.11
1993	1	1	2.7	0.9	2.2	1.1	1.6	0.8	93.6	11.2	2.4	1.5	231.6	37.6	0.75	0.24
	1	50	3.0	0.9	3.0	4.0	1.8	1.8	90.7	10.8	5.2	3.4	240.2	22.8	0.42	0.20
	2	1	2.9	1.0	3.2	3.5	2.6	3.3	97.0	12.0	1.8	0.5	230.3	41.5	0.77	0.29
	2	50	2.5	0.1	3.2	2.5	2.8	2.5	85.4	3.8	5.4	3.7	247.7	30.6	0.40	0.22

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Year	Station	Depth (m)	Total-P (µg/L)	SD	Total filterable-P (µg/L)	SD	Filterable reactive-P (µg/L)	SD	Total Kjeldahl nitrogen (µg/L)	SD	Ammonia (µg/L)	SD	Nitrate+nitrite (µg/L)	SD	Chlorophyll *a* (µg/L)	SD
1994	1	1	3.2	1.3	1.9	1.5	1.5	1.1	101.8	3.9	3.2	4.7	204.3	22.1	0.26	0.21
	1	50	3.9	2.0	1.2	0.2	1.1	0.4	97.5	16.1	6.7	3.6	218.1	18.3	0.21	0.13
	2	1	2.8	0.7	2.2	1.5	1.4	0.9	105.7	12.8	1.6	1.3	202.1	17.2	0.31	0.15
	2	50	3.3	1.2	2.2	1.3	1.9	1.1	105.6	13.2	5.8	2.5	225.7	20.6	0.20	0.07
1995	1	1	3.4	2.2	0.9	0.1	0.9	0.2	108.8	12.3	2.2	1.6	203.1	26.8	0.95	0.49
	1	50	3.4	1.3	1.5	0.3	1.4	0.4	105.6	20.4	3.5	2.4	241.6	6.6	0.58	0.44
	2	1	3.9	2.0	1.2	0.4	1.1	0.2	125.2	24.1	2.2	1.0	213.4	19.8	1.02	0.41
	2	50	3.2	0.9	0.9	0.2	0.9	0.1	108.2	18.6	4.5	3.0	243.1	9.1	0.58	0.45
1996	1	1	2.7	0.6	1.5	0.9	1.0	0.5	113.4	34.1	5.1	2.8	183.6	18.5	0.49	0.16
	1	50	3.0	1.1	1.3	0.7	1.0	0.4	90.5	18.5	9.3	5.0	210.8	9.0	0.51	0.23
	2	1	2.7	0.7	1.4	0.7	1.1	0.3	105.5	20.7	5.6	1.6	180.2	14.4	0.47	0.14
	2	50	4.4	1.7	1.5	0.7	1.5	1.3	101.1	16.9	10.2	4.1	217.9	2.4	0.57	0.33
1997	1	1	3.0	0.6	3.4	3.5	3.5	4.1	103.6	12.0	11.2	5.8	147.4	31.1	0.57	0.35
	1	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.58	0.37
	1	50	2.8	0.7	1.8	0.4	1.8	0.5	90.5	5.2	11.1	6.3	191.0	19.7	0.38	0.22
	2	1	3.1	0.9	3.2	3.3	3.1	3.2	106.1	11.3	11.2	6.4	168.2	25.2	0.59	0.35
	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.57	0.32
	2	50	3.8	1.5	3.1	1.0	3.2	1.0	107.4	30.3	10.7	6.2	188.3	17.5	0.44	0.24
1998	1	1	4.8	1.6	2.7	1.8	1.7	1.0	138.3	20.5	8.4	6.1	121.5	24.7	0.43	0.25
	1	50	4.0	0.4	1.6	0.8	1.3	0.5	118.4	10.1	10.2	5.4	174.4	19.6	0.14	0.04
	2	1	3.9	1.2	1.5	1.1	1.4	0.6	124.6	10.1	4.9	1.4	148.3	12.2	0.38	0.28
	2	50	4.0	1.7	1.5	0.9	1.5	0.7	122.9	12.0	9.6	4.5	171.9	26.4	0.21	0.12
1999	1	1	4.0	2.5	1.9	0.5	1.5	0.5	93.0	4.8	6.4	2.9	188.0	33.8	0.49	0.30
	1	50	3.2	0.4	1.7	0.7	1.2	0.5	92.0	2.7	6.9	3.8	211.4	6.1	0.15	0.05
	2	1	2.7	0.3	2.3	0.7	1.7	0.4	103.5	14.3	6.2	4.1	193.4	24.0	0.30	0.22
	2	50	3.0	0.6	2.3	1.6	1.7	1.4	87.9	15.3	11.2	6.0	208.1	10.1	0.25	0.14

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		Depth	Total-P		Total filterable-P		Filterable reactive-P		Total Kjeldahl nitrogen		Ammonia		Nitrate+nitrite		Chlorophyll *a*	
Year	Station	(m)	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD	(µg/L)	SD
2000	1	1	7.0	4.5	3.4	3.8	2.3	2.2	ND	–	8.7	8.6	195.5	1.8	0.58	0.14
	2	1	6.1	8.7	3.3	4.6	2.0	2.0	ND	–	7.5	8.0	184.0	15.7	0.77	0.18
2001	1	1	4.9	3.3	3.5	2.1	1.9	2.0	101.2	8.0	4.6	4.7	193.8	6.7	0.60	0.30
	2	1	6.7	5.1	3.5	3.3	2.7	3.5	ND	–	2.1	1.3	189.2	7.3	0.60	0.10
2002	1	1	3.3	2.6	1.5	0.9	3.0	1.9	96.7	14.5	5.0	2.3	136.5	7.9	0.32	0.00
	2	1	4.0	1.9	1.3	1.3	1.9	1.0	ND	–	3.4	1.7	135.0	21.2	0.45	0.18
2003	1	1	5.7	0.8	2.8	3.4	2.6	1.7	100.3	9.9	2.6	2.1	203.3	36.7	0.70	0.40
	2	1	3.5	0.7	1.4	1.1	3.6	0.8	ND	–	1.9	2.0	201.3	22.1	0.60	0.30
2004	1	1	4.4	2.9	0.9	0.9	1.5	1.1	98.7	47.6	6.8	2.1	197.3	19.1	0.60	0.25
	2	1	4.6	4.4	2.0	3.9	2.0	0.9	ND	–	7.2	1.3	186.4	19.6	0.82	0.71
2005	1	1	2.7	1.2	1.8	1.5	0.5	1.2	147.4	135.4	4.7	1.6	139.5	28.2	0.51	0.20
	2	1	4.1	0.7	1.0	0.9	0.5	0.7	152.6	62.0	4.9	2.0	142.5	15.6	0.52	0.04
2006	1	1	1.4	1.3	1.7	0.2	1.0	0.5	255.9	166.5	7.0	1.4	182.7	15.3	0.68	0.25
	2	1	1.7	1.3	1.5	0.2	0.9	0.4	ND	–	7.2	1.5	181.8	17.2	0.74	0.23
2007	1	1	2.3	0.6	1.0	0.7	0.4	0.1	127.8	27.8	5.1	1.5	171.0	23.2	0.64	0.39
	2	1	2.1	0.9	0.8	0.4	0.6	0.3	ND	–	5.8	3.4	165.6	25.6	0.58	0.42
2008	1	1	2.1	0.4	0.9	0.3	1.7	1.6	105.8	68.3	4.4	1.0	186.6	20.3	0.71	0.56
	2	1	2.7	0.4	1.1	0.8	1.0	1.1	76.0	56.2	4.6	1.6	178.4	13.5	0.64	0.39
2009	1	1	3.0	1.2	0.5	0.5	1.7	0.9	130.0	58.4	4.4	1.3	185.8	16.5	0.54	0.31
	2	1	2.5	1.2	1.1	1.1	1.8	0.7	103.0	57.1	4.8	1.6	193.2	14.4	0.34	0.22
2010	1	1	1.8	0.3	1.3	0.4	1.1	0.4	87.6	35.9	4.2	1.0	179.5	25.4	0.36	0.16
	2	1	2.6	0.2	1.1	0.4	0.9	0.2	108.2	24.4	4.2	1.4	180.8	23.3	0.47	0.10
Mean 1 m (1988–1989)			3.8	0.7	2.2	0.7	1.9	0.6	97.4	10.4	9.4	4.8	233.7	18.5	0.32	0.09
Mean 1 m (1990–2009)			3.8	2.0	2.4	1.8	2.2	1.4	104.7	31.4	5.8	3.1	204.3	26.6	0.46	0.22

Note: The epilimnion consists of samples taken from a depth of 1 meter and the hypolimnion consists of samples taken from a depth of 50 meters.

Table 4.–Summary of Spiridon Lake cladoceran and copepod weighted mean density, biomass, and their comparative ratios, 1988-2010.

	Cladoceran		Copepod		Total		Cladoceran to Copepod ratios [a]	
	Density	Biomass	Density	Biomass	Density	Biomass	Abundance	Biomass
Year	No./m^3	mg/m^3	No./m^3	mg/m^3	No./m^3	mg/m^3	Ratio	Ratio
1988	1,120	5.3	4,006	11.7	5,126	17.0	0.28 :1	0.45 :1
1989	1,308	4.9	9,826	15.8	11,134	20.7	0.13 :1	0.31 :1
1990	1,055	5.1	6,361	17.7	7,416	22.8	0.17 :1	0.29 :1
1991	834	3.4	8,862	18.8	9,696	22.2	0.09 :1	0.18 :1
1992	980	4.5	6,996	21.7	7,976	26.2	0.14 :1	0.21 :1
1993	878	2.9	5,616	10.3	6,494	13.2	0.16 :1	0.29 :1
1994	1,517	4.7	4,977	10.0	6,494	14.7	0.30 :1	0.47 :1
1995	1,589	6.4	4,538	12.0	6,127	18.4	0.35 :1	0.53 :1
1996	1,180	5.2	7,762	17.1	8,942	22.3	0.15 :1	0.30 :1
1997	1,531	6.7	2,477	6.3	4,008	13.0	0.62 :1	1.06 :1
1998	1,715	6.8	7,262	10.5	8,977	17.3	0.24 :1	0.65 :1
1999	726	2.6	1,450	3.5	2,176	6.1	0.50 :1	0.74 :1
2000	1,580	5.0	7,526	9.8	9,106	14.8	0.21 :1	0.50 :1
2001	1,752	7.6	1,467	4.4	3,219	12.0	1.19 :1	1.70 :1
2002	2,211	11.3	5,045	9.9	7,256	21.2	0.44 :1	1.15 :1
2003	2,785	6.8	4,160	7.1	6,945	13.9	0.67 :1	0.95 :1
2004 [b]	1,679	3.6	1,567	3.0	3,246	6.6	1.07 :1	1.19 :1
2005 [b]	3,329	10.2	1,671	2.7	5,000	12.9	1.99 :1	3.72 :1
2006 [c]	1,453	5.1	279	0.9	1,732	6.0	5.21 :1	5.67 :1
2007	1,688	4.0	567	1.7	2,255	5.7	2.98 :1	2.33 :1
2008	1,485	4.2	639	2.2	2,124	6.3	2.32 :1	1.92 :1
2009	1,499	6.2	3,865	9.6	5,364	15.8	0.39 :1	0.65 :1
2010	891	2.8	1,547	4.3	2,438	7.2	0.58 :1	0.66 :1
Mean (1988–1989)	1,214	5.1	6,916	13.8	8,130	18.9	0.18 :1	0.37 :1
Mean (1990–2009)	1,573	5.6	4,154	9.0	5,728	14.6	0.38 :1	0.63 :1
Mean (1991–2001, 2008–2010)					5,939			
Mean (2002–2007)					4,406			

[a] Values based on seasonal mean density and biomass.

[b] Values in 2004 were derived from 10 sampling dates, in 2005 from 8 sampling dates.

[c] Values include five sampling dates from each station only (5/23 or 5/16, 6/27, 8/1, 9/5, and 9/23).

Table 5.–Spiridon Lake weighted mean copepod density and biomass by species and the *Diaptomus* to *Cyclops* abundance ratio, 1988–2010.

Year	Number of Samples	*Epischura*		*Diaptomus*		*Cyclops*		Totals		*Diaptomus: Cyclops* Ratio [a]
		Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	
1988	4	0	0.0	1,067	4.9	2,939	6.8	4,006	11.7	0.36 :1
1989	5	0	0.0	2,199	6.7	7,627	9.1	9,826	15.8	0.29 :1
1990	5	0	0.0	2,228	9.4	4,134	8.3	6,361	17.7	0.54 :1
1991	7	0	0.0	2,276	7.5	6,587	11.3	8,862	18.8	0.35 :1
1992	6	0	0.0	504	3.1	6,492	18.6	6,996	21.7	0.08 :1
1993	6	5	0.0	221	1.1	5,395	9.2	5,621	10.3	0.04 :1
1994	6	0	0.0	155	0.8	4,822	9.2	4,977	10.0	0.03 :1
1995	6	0	0.0	266	2.5	4,272	9.5	4,538	12.0	0.06 :1
1996	6	0	0.0	69	0.4	7,693	16.7	7,762	17.1	0.01 :1
1997	6	0	0.0	64	0.5	2,413	5.8	2,477	6.3	0.03 :1
1998	5	0	0.0	163	0.9	7,099	9.6	7,262	10.5	0.02 :1
1999	5	0	0.0	97	0.5	1,353	3.0	1,450	3.5	0.07 :1
2000	5	133	0.2	61	0.3	7,332	9.3	7,526	9.8	0.01 :1
2001	5	46	0.1	95	0.9	1,326	3.4	1,467	4.4	0.07 :1
2002	5	81	0.1	459	2.5	4,506	7.3	5,045	9.9	0.10 :1
2003	4	381	0.4	593	2.6	3,186	4.1	4,160	7.1	0.19 :1
2004	10	57	0.1	100	0.7	1,410	2.3	1,567	3.0	0.07 :1
2005	8	36	0.0	45	0.2	1,590	2.5	1,671	2.7	0.03 :1
2006 [b]	5	3	0.0	17	0.1	259	0.8	279	0.9	0.07 :1
2007	5	11	0.0	56	0.3	501	1.4	567	1.7	0.11 :1
2008	5	54	0.2	24	0.2	561	1.8	639	2.2	0.04 :1
2009	5	5	0.0	154	1.2	3,706	8.4	3,865	9.6	0.04 :1
2010	5	45	0.1	264	1.7	1,238	2.5	1,547	4.3	0.21 :1
Mean (1988–1989)	5	0	0.0	1,633	5.8	5,283	8.0	6,916	13.8	0.31 :1
Mean (1990–2009)	6	41	0.1	382	1.8	3,732	7.1	4,155	9.0	0.10 :1

[a] Values based on mean density.

[b] Values include five sampling dates from each station only (5/23 or 5/16, 6/27, 8/1, 9/5, and 9/23).

Table 6.–Summary of the Spiridon Lake weighted mean density and biomass of cladocerans by species and the *Bosmina* to *Daphnia* abundance ratio, 1988–2010.

		Bosmina		*Daphnia*		*Holopedium*		Totals		*Bosmina: Daphnia*
Year	Number of Samples	Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	Density No./m^3	Biomass mg/m^3	ratio [a]
1988	4	724	2.6	381	2.6	15	0.1	1,120	5.3	1.90 :1
1989	5	759	2.2	441	1.9	108	0.8	1,308	4.9	1.72 :1
1990	5	424	1.4	601	3.6	30	0.1	1,055	5.1	0.70 :1
1991	7	144	0.4	662	2.9	28	0.1	834	3.4	0.22 :1
1992	6	298	1.0	614	3.0	68	0.5	980	4.5	0.49 :1
1993	6	324	0.9	479	1.4	75	0.6	878	2.9	0.68 :1
1994	6	561	1.5	801	2.0	155	1.2	1,517	4.7	0.70 :1
1995	6	599	1.5	591	1.6	399	3.3	1,589	6.4	1.01 :1
1996	6	571	1.9	427	1.6	182	1.7	1,180	5.2	1.34 :1
1997	6	652	1.8	526	2.2	353	2.7	1,531	6.7	1.24 :1
1998	5	474	1.2	915	4.4	326	1.2	1,715	6.8	0.52 :1
1999	5	374	1.2	216	0.7	136	0.7	726	2.6	1.73 :1
2000	5	855	2.0	442	1.2	282	1.7	1,580	5.0	1.94 :1
2001	5	664	1.9	793	2.5	294	3.2	1,752	7.6	0.84 :1
2002	5	714	2.1	485	2.4	1,012	6.9	2,211	11.3	1.47 :1
2003	4	1,671	3.2	826	1.7	288	1.9	2,785	6.8	2.02 :1
2004	10	638	1.4	999	2.0	42	0.2	1,679	3.6	0.64 :1
2005	8	1,745	4.1	1,122	1.9	462	4.2	3,329	10.2	1.56 :1
2006 [b]	5	516	1.1	559	0.9	378	3.1	1,453	5.1	0.92 :1
2007	5	653	1.3	747	1.2	288	1.5	1,688	4.0	0.87 :1
2008	5	592	1.7	880	2.3	13	0.2	1,485	4.2	0.67 :1
2009	5	947	2.7	176	0.4	376	3.1	1,499	6.2	5.38 :1
2010	5	407	0.9	124	0.4	360	1.5	891	2.8	3.28 :1
Mean (1988–1989)	5	741	2.4	411	2.3	62	0.5	1,214	5.1	1.80 :1
Mean (1990–2009)	6	671	1.7	643	2.0	259	1.9	1,573	5.6	1.04 :1

[a] Values based on mean density.

[b] Values include five sampling dates from each station only (5/23 or 5/16, 6/27, 8/1, 9/5, and 9/23).

Table 7.–Seasonal weighted mean lengths (mm) of zooplankton taxa in Spiridon Lake, 1988–2010.

Year	*Diaptomus*	*Cyclops*	*Bosmina*	*Daphnia*	*Holopedium*
1988	1.02	0.82	0.61	1.20	0.73
1989	0.89	0.60	0.56	0.96	0.82
1990	1.00	0.76	0.59	1.10	0.69
1991	0.94	0.70	0.55	0.99	0.76
1992	1.13	0.91	0.60	1.01	0.91
1993	1.06	0.70	0.51	0.80	0.83
1994 [a]	1.09	0.75	0.55	0.75	0.85
1995 [a]	1.30	0.79	0.51	0.78	0.83
1996 [a]	0.99	0.78	0.58	0.92	0.91
1997 [a]	1.26	0.82	0.54	1.00	0.84
1998	1.09	0.63	0.52	0.90	0.58
1999	1.06	0.78	0.58	0.92	0.63
2000	1.14	0.61	0.51	0.79	0.76
2001	1.34	0.85	0.55	0.84	0.97
2002	1.12	0.69	0.55	1.02	0.80
2003	1.01	0.62	0.45	0.68	0.80
2004 [b]	1.14	0.70	0.50	0.72	0.68
2005 [b]	1.00	0.67	0.50	0.62	0.79
2006 [b]	1.10	0.93	0.47	0.60	0.86
2007	1.13	0.88	0.46	0.61	0.73
2008	1.14	0.95	0.55	0.76	0.96
2009	1.24	0.80	0.54	0.74	0.88
2010	1.16	0.76	0.47	0.86	0.67
Mean (1988–1989)	0.95	0.71	0.58	1.08	0.77
Mean (1990–2009)	1.12	0.77	0.53	0.81	0.81
Mean (1990–2001; prior to pre-smolt stocking)			0.55		
Mean (2002–2007; during to pre-smolt stocking)			0.49		
Mean (2007–2008; after pre-smolt stocking)			0.55		

[a] From 1994–1997 average lengths were derived from samples collected at 4 sampling stations. In most years, average lengths were derived from samples collected at 2 sampling stations.

[b] From 2004–2006 average lengths were derived from a subset of 5 sample dates, not the complete set of 8–10 samples that were collected. Only 5 sample dates were used for average length calculations to maintain interannual comparability.

Table 8.–Sockeye salmon stocking numbers, life stage, size and release date, by year into Spiridon Lake, 1990–2010.

Year	# Fry	Date/Size[a]	# Fingerling	Date/Size[a]	# Pre-Smolt	Date/Size[a]	Total Stocked
1990	249,346	ND/ND					249,346
1991	3,480,000	7-Jul/0.3 g					3,480,000
1992	2,200,000	20-Jun/0.2 g					2,200,000
1993	4,246,000	9-Jun/0.2 g					4,246,000
1994	4,400,000	24-May/0.2 g					5,676,000
	1,276,000	9-Jun/0.2 g					
1995	2,813,000	26-Jun/0.3 g	1,786,000	5-Jul/0.4 g			4,599,000
1996	1,100,000	21-May/0.2 g	3,744,000	26-Jun/0.4 g			4,844,000
1997	4,200,000	28-Jun/0.2 g	1,200,000	24-Jul/0.5 g			6,700,000
	1,300,000	12-Jul/0.3 g					
1998	784,000	18-Jun/0.4 g	2,556,000	13-Jul/0.9 g			3,340,000
1999	600,000	18-Jun/0.3 g	2,160,000	8-29Jul/1.0 g			3,564,000
			804,000	2-17Jul/2.0 g			
2000	535,000	25-May/0.3 g	507,100	23-Aug/3.0 g			4,397,100
	3,355,000	11-Jun/0.4 g					
2001			1,700,600	21-Jun/0.8 g			1,700,600
2002			366,000	30-Jul/1.2 g	586,900	4-Oct/8.5 g	952,900
2003			730,744	29-Jun/1.2 g	686,775	9-Oct/11.8 g	1,417,519

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Year	# Fry	Date/Size[a]	# Fingerling	Date/Size[a]	# Pre-Smolt	Date/Size[a]	Total Stocked
2004			2,008,205	19-Jun/0.5 g	501,220	5-7-Oct/11.5 g	2,797,644
			288,219	16-Aug/4.1 g			
2005			693,176	23-Jun/0.8 g	508,492	2-3-Oct/8.4 g	1,201,668
2006	2,765,088	23-24-Jun/0.4 g			431,424	5-6-Oct/9.9 g	3,196,512
2007	1,559,868	17-Jun/0.3 g			250,243	28-Sep/5.7 g	1,810,111
2008	1,049,809	27-Jun/0.3 g					1,049,809
2009			1,560,000	8-Jul/0.5 g			1,560,000
2010	2,817,803	26-27-Jun/0.4 g					3,006,265
	188,462	27-Jun/0.3 g					
Mean (1991–2009)							3,091,203
Mean (1991–2001, 2008–2010)							3,597,341
Mean (2002–2007)							1,896,059

[a] Life stages are determined by emergent weight (g). Two times emergent weight is called a fingerling and 20 times emergent weight is called a pre-smolt. Release dates typically spanned several days due to the large number of juveniles to be released and weather delays. Therefore, weights were averaged for multiple release dates.

Table 9.–Spiridon Lake sockeye salmon total smolt emigration and mortality estimates by year and age, 1992–2010.

	Number and Proportions of Smolt by Age Class			Total	Total	Number and Proportions of Live Smolt by Age Class			Total Live
Year	1.	2.	3.	Smolt	Mortality	1.	2.	3.	Smolt
1992	1,466,995	17,826	0	1,484,821	87,169	1,380,321	17,331	0	1,397,652
	98.8%	1.2%	0.0%	100.0%	5.9%	98.8%	1.2%	0.0%	100.0%
1993	260,115	85,443	0	345,558	15,433	249,784	80,341	0	330,125
	75.3%	24.7%	0.0%	100.0%	4.5%	75.7%	24.3%	0.0%	100.0%
1994	599,717	244,360	6,271	850,348	3,123	597,502	243,464	6,259	847,225
	70.5%	28.7%	0.7%	100.0%	0.4%	70.5%	28.7%	0.7%	100.0%
1995	314,604	299,556	831	614,992	21,030	304,326	288,822	813	593,961
	51.2%	48.7%	0.1%	100.0%	3.4%	51.2%	48.6%	0.1%	100.0%
1996	918,540	135,414	1,232	1,055,186	23,120	897,762	133,097	1,207	1,032,066
	87.1%	12.8%	0.1%	100.0%	2.2%	87.0%	12.9%	0.1%	100.0%
1997	654,293	237,492	2,934	894,719	25,551	635,650	230,685	2,833	869,168
	73.1%	26.5%	0.3%	100.0%	2.9%	73.1%	26.5%	0.3%	100.0%
1998	529,726	216,923	301	746,950	21,321	514,606	210,731	292	725,629
	70.9%	29.0%	0.0%	100.0%	2.9%	70.9%	29.0%	0.0%	100.0%
1999	812,267	123,458	373	936,118	37,331	779,875	118,534	358	898,787
	86.8%	13.2%	0.0%	100.0%	4.0%	86.8%	13.2%	0.0%	100.0%
2000	792,029	493,529	5,133	1,290,692	4,384	788,909	492,275	5,122	1,286,306
	61.4%	38.2%	0.4%	100.0%	0.3%	61.3%	38.3%	0.4%	100.0%

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	Number and Proportions of Smolt by Age Class			Total	Total	Number and Proportions of Live Smolt by Age Class			Total Live
Year	1.	2.	3.	Smolt	Mortality	1.	2.	3.	Smolt
2001	1,093,246	442,975	0	1,536,221	7,305	1,087,695	441,221	0	1,528,916
	71.2%	28.8%	0.0%	100.0%	0.5%	71.1%	28.9%	0.0%	100.0%
2002	441,964	92,484	0	534,448	12,523	431,542	90,384	0	521,925
	82.7%	17.3%	0.0%	100.0%	2.3%	82.7%	17.3%	0.0%	100.0%
2003	228,857	34,854	914	264,624	1,777	227,363	34,696	789	262,847
	86.5%	13.2%	0.3%	100.0%	0.7%	86.5%	13.2%	0.3%	100.0%
2004	540,748	36,882	1,274	578,904	1,249	539,582	36,804	1,269	577,655
	93.4%	6.4%	0.2%	100.0%	0.2%	93.4%	6.4%	0.2%	100.0%
2005	1,368,763	48,326	4,264	1,421,353	11,979	1,357,702	47,636	4,036	1,409,374
	96.3%	3.4%	0.3%	100.0%	0.8%	96.3%	3.4%	0.3%	100.0%
2006	471,241	94,932	0	566,173	1,214	470,231	94,728	0	564,959
	83.2%	16.8%	0.0%	100.0%	0.2%	83.2%	16.8%	0.0%	100.0%
2007	387,179	96,795	0	483,974	4,563	383,529	95,882	0	479,411
	80.0%	20.0%	0.0%	100.0%	0.9%	80.0%	20.0%	0.0%	100.0%
2008	117,370	426,010	0	543,380	4,876	116,491	422,013	0	538,504
	21.6%	78.4%	0.0%	100.0%	0.9%	21.6%	78.4%	0.0%	100.0%
2009	132,681	203,901	0	336,582	8,659	129,267	198,656	0	327,923
	39.4%	60.6%	0.0%	100.0%	2.6%	39.4%	60.6%	0.0%	100.0%
2010	561,637	148,048	0	709,685	40,342	529,711	139,632	0	669,343
	79.1%	20.9%	0.0%	100.0%	5.7%	79.1%	20.9%	0.0%	100.0%
Mean	618,352	185,064	1,307	804,725	16,256	633,110	182,072	1,277	788,468
(1992–2009)	76.8%	23.0%	0.2%	100.0%	2.0%	80.3%	23.1%	0.2%	100.0%

Note: Age percentages differ from those in Table 10. Values in Table 9 have been adjusted from those given in Table 10, to account for non-aged emigrating smolt (i.e. daily sockeye smolt aged, proportioned for total outmigration). Percentages in table 9 may not add up exactly due to rounding.

Table 10.–Mean length, weight, and condition coefficient by age of sockeye salmon smolt captured by trap emigrating from Spiridon Lake, 1991–2010.

	Age-1.						Age-2.						Age-3.					
Year	N [a]	N [b]	% Captured	Length (mm)	Weight (g)	Condition (K)	N [a]	N [b]	% Captured	Length (mm)	Weight (g)	Condition (K)	N [a]	N [b]	% Captured	Length (mm)	Weight (g)	Condition (K)
1991	596	596	100.0	127	19.3	1.08	0	0	0.0	–	–	–	0	0	0.0	–	–	–
1992	1,393	1,389	98.8	115	12.7	0.81	16	14	1.1	183	58.9	0.80	0	0	0.0	–	–	–
1993	817	493	66.8	116	13.4	0.83	404	240	33.0	155	33.8	0.88	2	2	0.2	178	50.7	0.90
1994	1,477	929	73.5	106	9.3	0.78	526	344	26.2	152	28.5	0.79	6	4	0.3	254	145.8	0.88
1995	1,697	999	60.9	104	9.2	0.81	1,081	667	38.8	138	25.1	0.95	6	5	0.2	244	102.8	0.84
1996	2,224	1,573	76.1	109	10.3	0.79	694	513	23.7	141	20.7	0.73	6	5	0.2	221	85.6	0.77
1997	1,428	876	66.2	102	8.6	0.80	720	441	33.4	137	20.6	0.80	11	6	0.5	169	41.9	0.81
1998	2,205	1,496	77.4	93	6.3	0.76	727	414	22.5	127	15.4	0.75	3	0	0.1	–	–	–
1999 [c]	1,452	799	73.6	95	7.0	0.80	518	336	26.3	122	14.1	0.78	2	1	0.1	126	15.0	0.75
2000	2,263	1,700	81.1	94	6.8	0.79	507	325	18.2	132	18.5	0.80	22	8	0.8	142	22.4	0.77
2001	2,037	2,037	80.1	104	8.8	0.78	506	506	19.9	136	20.2	0.79	0	0	0.0	–	–	–
2002	1,716	1,716	86.6	118	12.7	0.77	266	266	13.4	155	30.2	0.80	0	0	0.0	–	–	–
2003	1,226	1,197	80.0	131	20.4	0.89	288	277	18.8	165	42.4	0.87	19	19	1.2	168	42.7	0.84
2004	1,325	1,325	89.0	127	16.8	0.80	160	160	10.8	184	51.3	0.80	3	3	0.2	227	97.7	0.84
2005	1,068	1,068	88.6	106	9.6	0.79	119	119	9.9	178	51.1	0.83	18	18	1.5	195	61.8	0.84
2006	871	871	88.1	107	9.7	0.75	118	118	11.9	158	32.6	0.82	0	0	0.0	–	–	–
2007	1,063	1,063	81.6	101	8.4	0.77	240	240	18.4	139	21.0	0.80	0	0	0.0	–	–	–
2008	371	371	46.8	92	5.4	0.70	422	422	53.2	127	15.6	0.75	0	0	0.0	–	–	–
2009	690	690	65.5	101	8.6	0.82	363	363	34.5	137	20.8	0.77	0	0	0.0	–	–	–
2010	840	840	82.1	114	11.8	0.79	183	183	17.9	142	23.6	0.81	0	0	0.0	–	–	–
Mean (1991–2009)			77.9	108	10.7	0.81			21.8	148	28.9	0.81			0.3	192	66.6	0.82

Note: Age percentages differ from those in Table 9. Values in Table 9 have been adjusted to account for non-aged emigrating smolt (i.e. daily sockeye smolt aged, proportioned for total outmigration).

[a] The number of smolt aged.

[b] The number of smolt sampled for length, weight, and condition.

[c] One smolt sampled was age 0. and was 96 mm; 6.6 g; 0.75 K.

Table 11.–Commercial harvest of salmon by species and day in the Spiridon Bay Special Harvest Area (statistical area 254-50), 2010.

Date [a]	Sockeye	Coho	Pink	Chum	Total
22–30-Jun					
2-Jul	10,203	0	31	52	10,286
3-Jul	3,331	0	12	21	3,364
4-Jul	5,948	0	249	32	6,229
5-Jul	2,066	0	17	12	2,095
6-Jul	7,153	0	76	88	7,317
7-Jul	1,649	0	30	31	1,710
8-Jul	6,150	0	232	260	6,642
9-Jul	2,654	0	143	201	2,998
10-Jul	1,062	0	4	22	1,088
11-Jul	202	0	5	10	217
12-Jul	5,957	0	301	185	6,443
13-Jul	2,677	0	111	49	2,837
14-Jul	2,709	0	324	231	3,264
15-Jul	8,483	0	916	351	9,750
16-Jul	1,713	0	1,938	75	3,726
17-Jul	3,594	0	1,404	263	5,261
18-Jul	406	0	276	54	736
19-Jul	3,188	1	1,829	448	5,466
20-Jul	972	1	827	476	2,276
21-Jul	549	0	918	120	1,587
22-Jul	275	0	991	185	1,451
23-Jul	2,523	18	5,223	941	8,705
24-Jul	282	0	713	153	1,148
25-Jul	300	0	212	23	535
26-Jul	560	0	538	75	1,173
27-Jul	1,859	4	3,542	319	5,724
28-Jul	2,469	2	5,175	141	7,787
29-Jul					
30-Jul	835	0	4,664	39	5,538
31-Jul					
1-Aug	2,717	0	6,547	136	9,400
2–3-Aug					
4-Aug	2,514	0	3,750	300	6,564
5–6-Aug					
7-Aug	852	1	4,628	90	5,571
8-Aug					
9-Aug	425	2	1,273	70	1,770
10–11-Aug					
Total	100,727	36	53,516	5,887	160,166

Note: Harvest numbers include “home pack” A sockeye salmon cost recovery harvest occurred from 22–30 June 2010.

[a] Harvest dates with confidential data and cost recovery (less than three landings) are left blank in the table.

Table 12.–Commercial harvest of salmon by species and year in the Spiridon Bay Special Harvest Area (statistical area 254-50), 1994–2010.

Year	Sockeye	Coho	Pink	Chum
1994	130,891	4,584	32,331	2,291
1995	11,889	2,194	46,422	2,169
1996	164,114	3,622	44,701	4,684
1997	66,480	4,889	54,236	2,575
1998	90,447	2,211	103,715	4,812
1999	192,773	2,149	61,004	13,700
2000	81,931	565	108,254	13,070
2001	59,733	345	70,883	12,885
2002	201,534	2,331	222,860	8,189
2003	259,714	66	73,549	10,643
2004	75,775	12	23,644	2,105
2005	59,494	0	33,254	2,106
2006	36,467	7	29,281	1,099
2007	70,250	15	52,638	3,233
2008	154,575	33	67,214	7,627
2009	81,725	0	48,921	6,081
2010 [a]	100,727	36	53,516	5,887
Mean (1994–2009)	108,612	1,439	67,057	6,079

Note: Harvest includes “home pack”.

[a] Included is a harvest of 10,840 sockeye salmon harvested for cost recovery.

Table 13.–Estimated age composition of adult sockeye salmon harvest from Spiridon Bay Special Harvest Area (statistical area 254-50), 1994–2010.

	Sample		Ages														
Year	Size		0.1	0.2	1.1	0.3	1.2	2.1	1.3	0.4	2.2	2.3	3.1	3.2	1.4	2.4	Total [a]
1994	1,329	Percent	0.0	0.0	0.1	0.0	99.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
		Numbers	0	0	149	0	114,624	356	30	0	21	9	0	0	0	0	115,189
1995	1,313	Percent	0.0	0.1	19.9	0.1	60.2	1.9	4.9	0.0	11.6	1.3	0.0	0.0	0.0	0.0	100.0
		Numbers	0	19	6,312	37	19,089	595	1,563	0	3,667	409	0	0	0	0	31,691
1996	1,875	Percent	0.0	0.0	1.8	0.0	79.0	4.6	0.2	0.0	14.3	0.0	0.1	0.0	0.0	0.0	100.0
		Numbers	0	0	2,846	0	128,123	7,448	303	0	23,192	0	111	97	0	0	162,120
1997	1,703	Percent	0.0	0.0	2.8	0.0	62.6	2.8	2.4		29.3	0.0	0.0	0.0	0.0	0.0	99.9
		Numbers	0	0	1,795	0	40,359	1,824	1,558	0.0	18,908	25	7	7	0	0	64,483
1998	1,943	Percent	0.0	0.0	4.2	0.0	81.8	2.0	0.6	0.0	10.7	0.5	0.0	0.1	0.0	0.0	99.9
		Numbers	0	0	3,726	0	72,354	1,785	543	0	9,448	485	0	111	0	0	88,452
1999	2,345	Percent	0.0	0.0	0.4	0.0	47.8	0.2	32.7	0.0	17.4	1.5	0.0	0.1	0.0	0.0	100.1
		Numbers	0	0	689	86	91,129	298	62,405	0	33,167	2,836	0	168	0	0	190,778
2000	1,997	Percent	0.0	0.0	0.1	0.1	71.5	0.2	3.0	0.0	18.3	6.6	0.0	0.1	0.1	0.0	100.0
		Numbers	0	9	122	60	58,559	176	2,419	0	14,987	5,446	0	110	42	0	81,930
2001	1,534	Percent	0.0	0.0	1.1	0.1	58.5	3.4	17.2	0.0	19.0	0.7	0.0	0.0	0.0	0.0	100.0
		Numbers	0	0	674	51	34,921	2,022	10,300	28	11,334	391	0	0	7	7	59,735
2002	1,572	Percent	0.0	0.0	0.2	0.0	36.1	2.0	35.8	0.0	24.7	1.0	0.0	0.1	0.1	0.0	100.0
		Numbers	0	0	466	59	71,962	4,077	71,479	0	49,330	1,909	0	119	139	0	199,539
2003	1,782	Percent	0.0	0.0	0.3	0.0	46.3	0.0	26.9	0.0	21.2	5.1	0.0	0.0	0.1	0.0	100.0
		Numbers	0	0	849	0	120,346	68	69,908	0	55,122	13,201	0	68	151	0	259,714

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Table 13.–Page 2 of 2.

Year	Sample Size		Ages														
			0.1	0.2	1.1	0.3	1.2	2.1	1.3	0.4	2.2	2.3	3.1	3.2	1.4	2.4	Total [a]
2004	1,761	Percent	0.0	0.0	0.1	0.0	27.8	0.0	54.6	0.0	7.8	9.4	0.0	0.0	0.2	0.0	100.0
		Numbers	0	0	101	29	21,029	22	41,349	0	5,880	7,156	0	29	160	0	75,775
2005	1,272	Percent	0.0	0.0	7.5	0.0	38.3	0.0	52.2	0.0	1.5	0.3	0.0	0.0	0.0	0.0	100.0
		Numbers	0	0	4,475	0	22,812	25	31,081	0	909	193	0	0	0	0	59,494
2006	999	Percent	0.0	0.0	0.4	0.0	83.0	0.4	11.9	0.0	3.0	0.3	0.0	0.0	1.0	0.0	100.0
		Numbers	0	0	157	0	30,277	141	4,354	0	1,082	92	0	0	363	0	36,467
2007	1,203	Percent	0.0	0.0	0.0	0.0	62.2	0.0	36.5	0.0	0.9	0.4	0.0	0.0	0.0	0.0	100.0
		Numbers	0	0	0	0	43,696	0	25,641	0	632	281	0	0	0	0	70,250
2008	1,482	Percent	0.0	0.0	0.0	0.0	19.4	0.0	62.6	0.0	16.0	1.6	0.0	0.0	0.4	0.0	100.0
		Numbers	0	0	0	0	29,968	0	96,701	0	24,716	2,472	0	0	281	0	154,475
2009	1,206	Percent	0.0	0.0	0.4	0.4	20.0	1.2	48.6	0.0	20.8	8.3	0.0	0.1	0.1	0.0	100.0
		Numbers	0	0	366	339	16,364	958	39,746	0	17,014	6,769	0	64	104	0	81,725
2010	1,370	Percent	0.2	0.2	0.0	0.0	17.4	0.1	19.8	0.0	55.0	6.7	0.0	0.0	0.0	0.0	99.2
		Numbers	175	175	0	0	17,541	667	19,921	0	55,441	6,763	0	0	42	0	100,727
Mean	1,621	Percent	0.0	0.0	1.3	0.0	52.2	1.2	26.8	0.0	15.8	2.5	0.0	0.0	0.1	0.0	100.0
(1994–2009)		Numbers	0	2	1,505	44	59,022	1,310	30,335	2	17,888	2,772	8	52	59	0	112,999

Note: Totals may not add up exactly due to rounding.

[a] Total includes "home pack" harvest.

Table 14.–Indexed aerial peak salmon escapements by species at Spiridon River (254-401), 1994–2010.

Year	Date	Observer	Survey Conditions	Survey counts [a] pink	chum	coho
1994	ND	ND	ND	ND	ND	ND
1995	17-Aug	ADF&G	good	87,800	22,000	
	13-Oct	FWS	good			10,300
1996	29-Aug	FWS	good	5,700	8,000	
	16-Oct	FWS	excellent			10,600
1997	1-Aug	ADF&G	good	18,100	5,500	
	9-Oct	ADF&G	excellent			13,300
1998	14-Aug	ADF&G	fair	29,500	6,150	
	14-Sep	FWS	good			1,750
1999	11-Aug	ADF&G	fair		15,000	
	27-Aug	ADF&G	fair	15,500		
2000	21-Aug	FWS	fair	1,000	16,500	
	20-Oct	FWS	good			2,900
2001	1-Aug	ADF&G	poor		3,000	
	7-Aug	ADF&G	fair	18,000		
	29-Oct	FWS	good			4,550
2002	2-Sep	ADF&G	fair to poor	32,000	6,500	
	3-Sep	ADF&G	poor		7,380	
					13,880 [b]	
2003	5-Aug	ADF&G	poor	5,000	5,700	
	5-Sep	ADF&G	poor			700
2004	ND	ND	ND	ND	ND	ND
2005 [c]	8-Aug	ADF&G	poor	5,000	6,400	0
	26-Aug	ADF&G	good to excellent	50	15,500	
2006	17-Aug	ADF&G	fair	14,700		
	26-Aug	ADF&G	fair		5,000	
2007	7-Aug	ADF&G	poor	10,000		
	6-Sep	ADF&G	fair	1,000	7,900	

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Table 14.–Page 2 of 2.

Year	Date	Observer	Survey Conditions	Survey counts [a] pink	chum	coho
2008	31-Jul	ADF&G	fair	9,400	200	0
	9-Aug	ADF&G	fair	32,000	11,400	0
2009 [d]	9-Aug	ADF&G	good	13,400	14,200	0
	19-Aug	ADF&G	good	6,300	4,300	0
	25-Aug	ADF&G	good	400	25,000	0
2010	14-Jul	ADF&G	poor	0	0	0
	28-Jul	ADF&G	poor	0	0	0
	6-Aug	ADF&G	fair	600	1,300	0
	30-Aug	ADF&G	poor	1,000	10,700	0

[a] Survey counts include stream, mouth, and bay areas.

[b] The 2002 peak chum estimate was a sum of the 2–3 September survey estimates. ADF&G manager's sum estimates were from surveys conducted on two consecutive days in determining the indexed peak count.

[c] The 8 August survey only included the upper river drainage.

[d] A survey count of 100 sockeye salmon carcasses were counted on 9 August.

Table 15.–Summary of Spiridon Lake phytoplankton mean biomass, by phylum, and year, 2004–2006, 2010.

		Phylum							
		Chlorophyta (Green Algae)	Chrysophyta (Golden-brown Algae)	Bacillariophyta (Diatoms)	Cryptophyta	Pyrrhophyta (Dinoflagellate)	Haptophyta	Cyanobacteria (Blue-green Algae)	Total
Date	Station	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)	Biomass (mg/m^3)
2004	1	1.5	10.0	170.1	0.8	9.6	1.8	0.2	194.0
2005	1	0.1	27.2	2.1	1.2	5.5	1.3	0.5	37.9
2006	1	0.4	19.0	5.8	2.6	1.6	1.6	0.7	31.7
2007		ND	ND	ND	ND	ND	ND	ND	–
2008		ND	ND	ND	ND	ND	ND	ND	–
2009		ND	ND	ND	ND	ND	ND	ND	–
2010	1	0.5	2.1	58.0	0.2	6.4	0.0	0.0	67.2
Mean (2004–2006)		0.7	18.7	59.4	1.6	5.6	1.6	0.4	87.9

Table 16.–Indexed foot survey peak salmon escapements by species at Telrod Creek (254-403), 1994–2010.

Year	Date	Sockeye [a]	Pink [a]
1994	ND	ND	ND
1995	15-Aug	120	233
1996	15-Sep	10	238
1997	11-Sep		350
	9-Oct	3,000	
1998	17-Aug	5,013	327
1999	31-Aug	1,220	
	10-Sep		60
2000	4-Sep	1,321	353
2001	18-Aug	1,600	450
2002	13-Aug		1,710
	17-Aug	1,880	
2003	14-Aug	5,252	450
2004	3-Aug	1,200	0
2005	11-Jul	500	100
2006 [b,c]	30-Jul	500	0
2007 [c]	29-Jul	300	0
2008 [c]	7-Jul	600	0
2009 [c]	31-Jul	25	0
2010 [c]	3-Aug	200	0

[a] Survey estimates include salmon in stream mouth.

[b] The 30 July survey was an estimate of salmon in the plunge pool at the first waterfall barrier and does not represent a survey of the entire stream to the barrier.

[c] As specified in the renewed SUP, foot surveys of Telrod creek are no longer required but included when conducted.

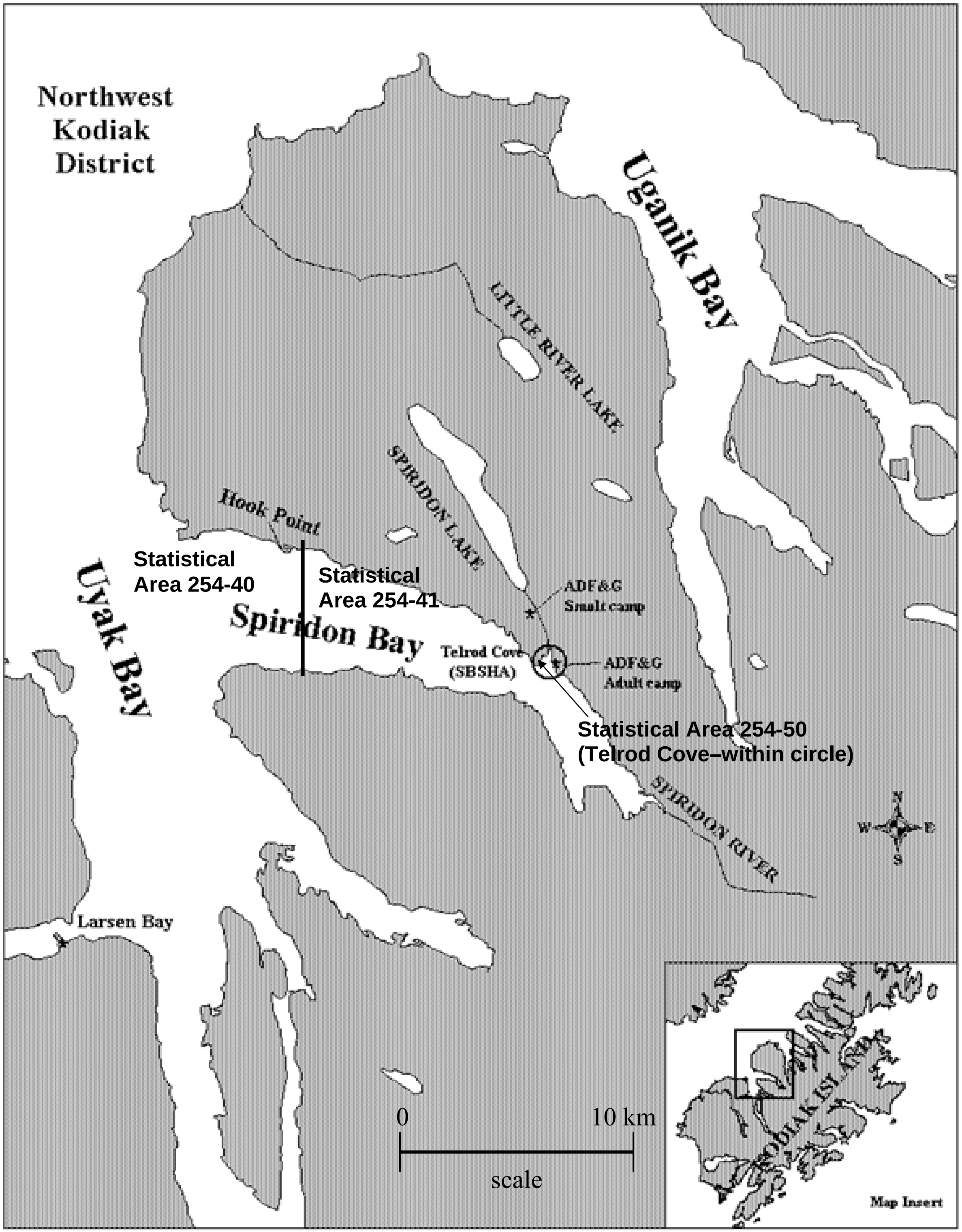

Figure 1.–Locations of ADF&G smolt and adult salmon field camps, Spiridon Lake, Telrod Cove, and Spiridon Bay in the Northwest Kodiak District.

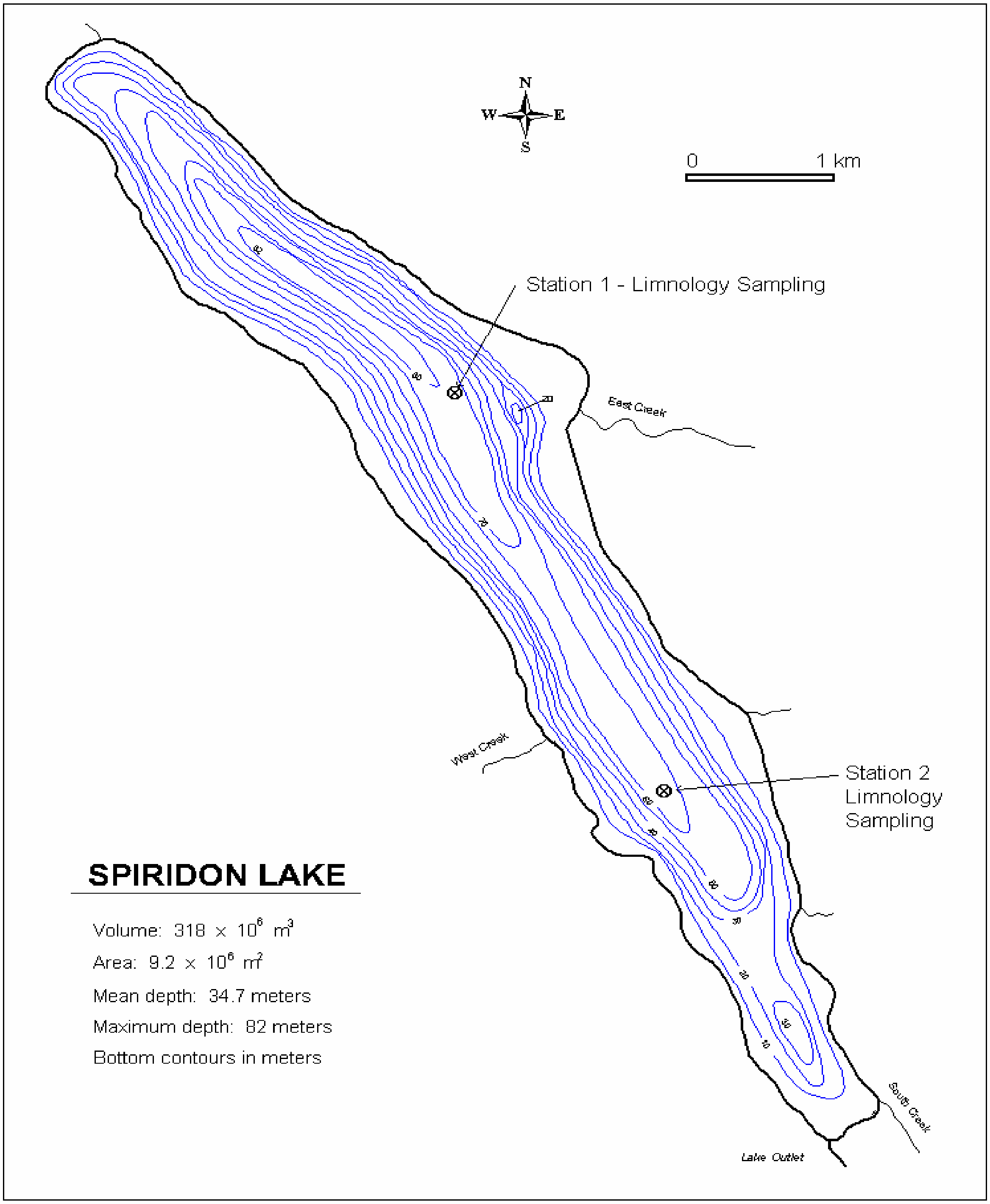

Figure 2.–Morphometric map showing the location of limnology sampling stations on Spiridon Lake.

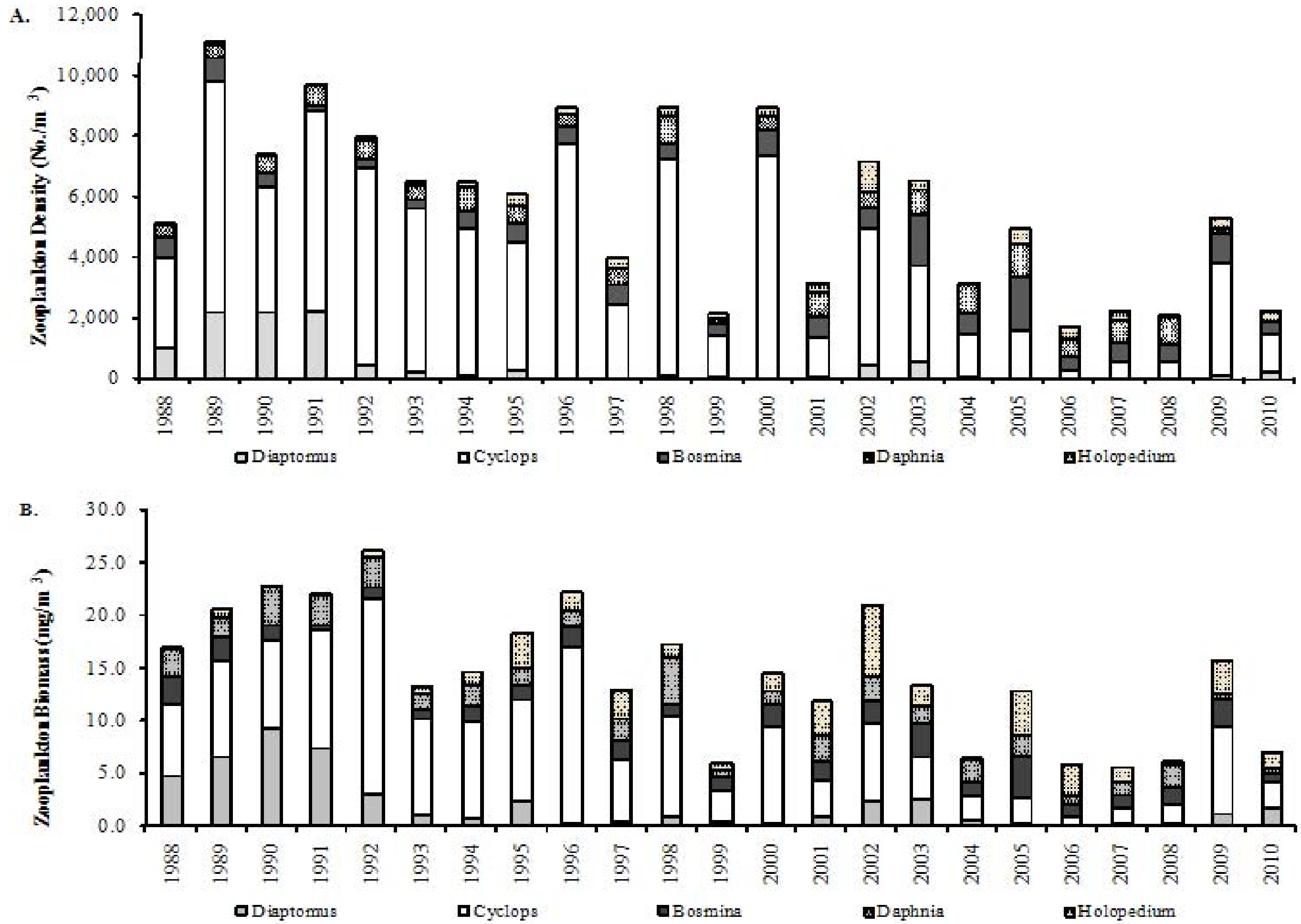

Figure 3.–Zooplankton density (A) and biomass (B) estimates for Spiridon Lake, 1988–2010.

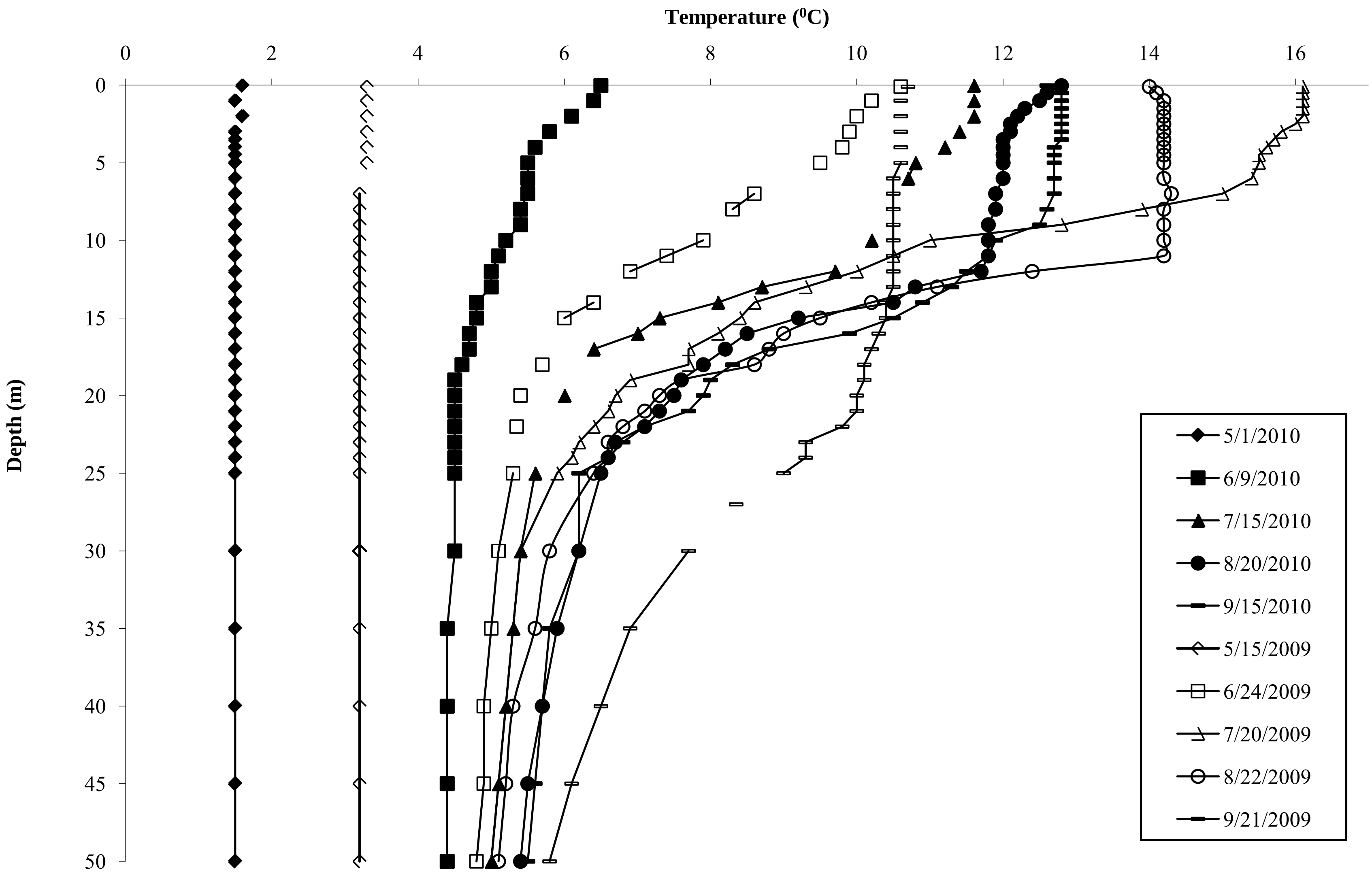

Figure 4.–Lake temperature profile (°C) for Spiridon Lake, 2010.

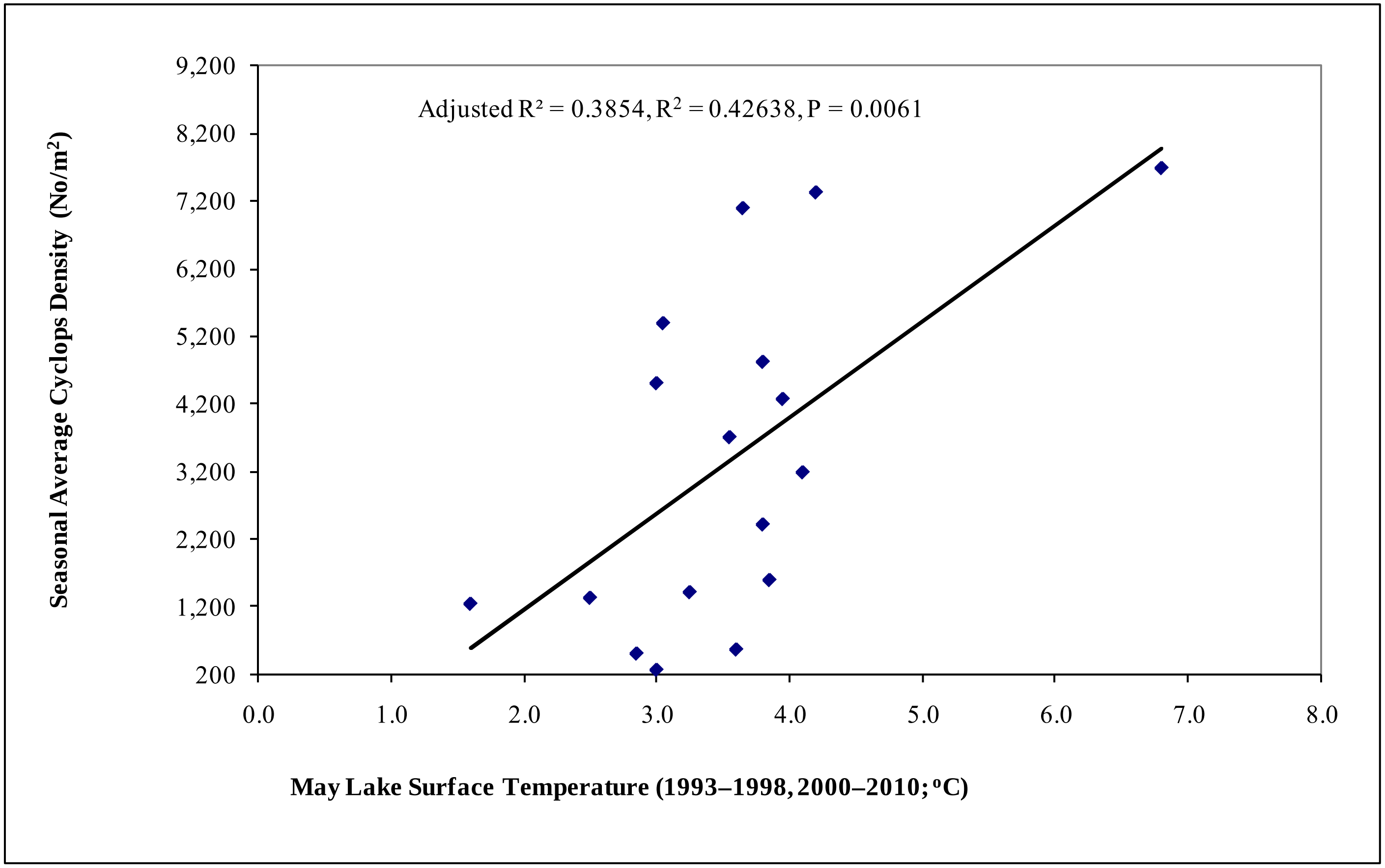

Figure 5.–Relationship between May lake temperature and seasonal average *Cyclops* density.

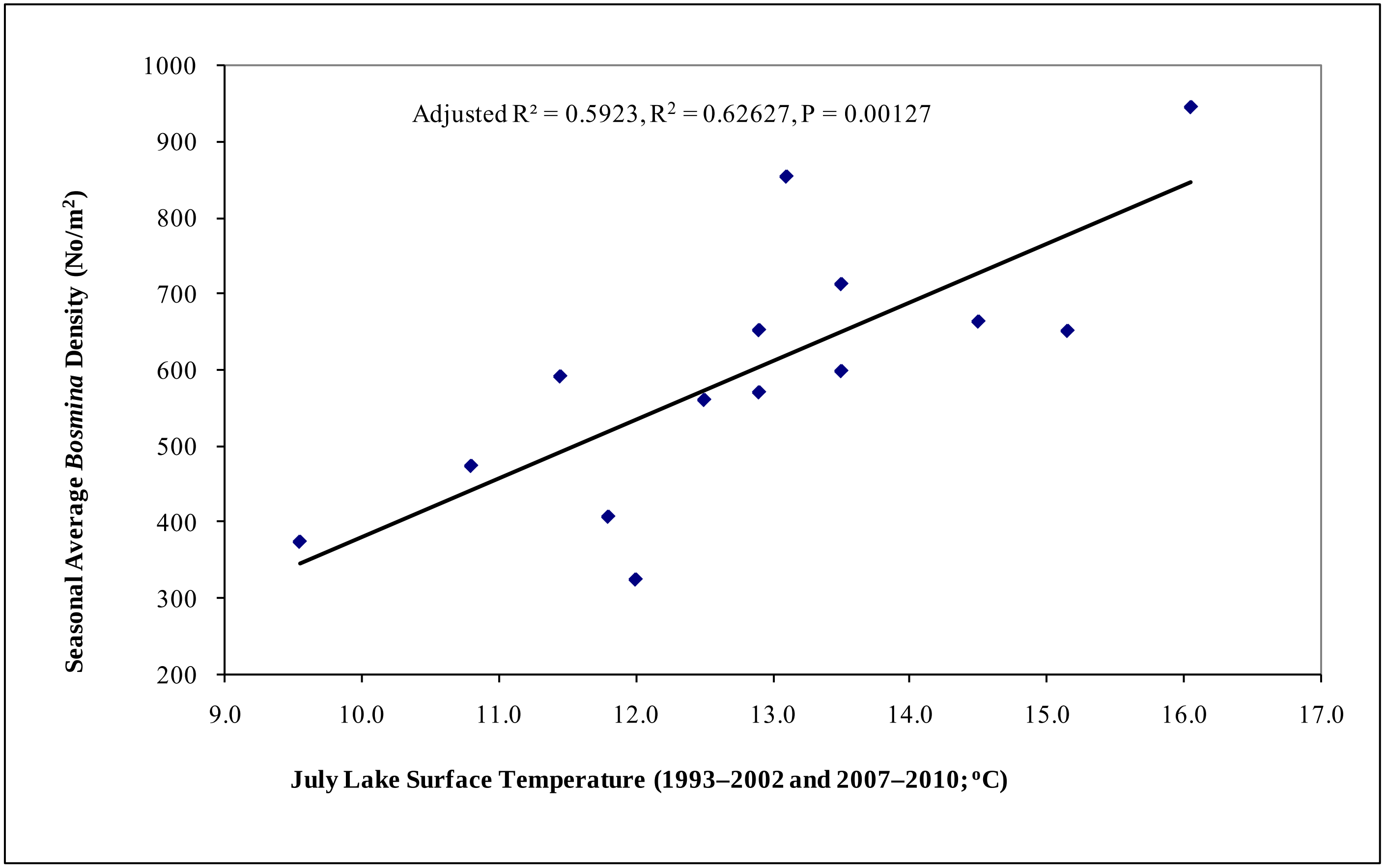

Figure 6.–Relationship between July lake temperature and seasonal average *Bosmina* density.

APPENDIX A. HISTORICAL LIMNOLOGICAL DATA

Appendix A1.–The number of limnological sampling stations and samples collected from Spiridon Lake, 1988–2010.

Year	Sampling Stations	Total Samples
1988	1, 2	4
1989	1, 2	5
1990	1, 2	5
1991	1, 2	7
1992	1, 2	6
1993	1, 2	6
1994	1– 4	6
1995	1– 4	6
1996	1– 4	6
1997	1– 4	6
1998	1, 2	5
1999	1, 2	6
2000	1, 2	5
2001	1, 2	5
2002	1, 2	5
2003	1, 2	4
2004	1, 2, 5, 6	10
2005	1, 2, 5, 6	9
2006	1, 2, 5, 6	7
2007	1, 2	5
2008	1, 2	5
2009	1, 2	5
2010	1, 2	5

Note: Sampling stations 5 and 6 were placed in tributaries entering Spiridon Lake.

Appendix A2.–Summary of seasonal mean water chemistry parameters by station and depth for Spiridon Lake, 1988–2010.

		Depth	Sp. Cond.		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(m)	(μ mhos/cm)	SD	(Units)	SD	(μ g L)	SD	(NTU)	SD	(Pt units)	SD	(μ g L)	SD	(μ g L)	SD	(μ g L)	SD
1988	1	1	71.5	1.0	7.1	0.2	20.8	1.7	0.6	0.3	7.0	2.3	6.1	1.0	2.3	0.5	16.5	3.0
	1	50	71.5	0.6	7.0	0.1	20.5	1.3	0.6	0.4	5.8	0.5	6.1	0.8	2.2	0.7	12.0	3.3
	2	1	71.7	0.6	7.1	0.2	20.0	1.0	0.4	0.1	8.0	0.0	7.7	2.8	1.3	1.6	16.3	5.9
	2	50	71.6	0.5	7.0	0.1	19.4	0.9	0.7	0.5	7.4	2.8	5.4	0.2	3.2	1.0	15.0	6.7
1989	1	1	75.0	6.2	7.3	0.2	22.2	2.8	0.3	0.1	13.8	6.4	5.7	1.0	2.0	0.3	8.6	3.6
	1	50	76.8	8.6	7.3	0.2	22.8	3.5	0.3	0.1	12.4	3.8	6.3	0.6	2.3	0.7	12.0	9.0
	2	1	73.6	1.5	7.3	0.2	21.4	0.9	0.7	0.6	12.0	3.9	5.9	0.4	2.4	0.4	25.2	35.4
	2	50	72.6	1.7	7.3	0.1	20.2	4.1	0.8	0.9	14.4	6.2	5.8	0.6	2.4	0.7	84.4	144.4
1990	1	1	76.2	7.2	7.4	0.2	23.7	2.6	0.5	0.4	5.0	1.9	5.7	0.9	2.2	0.6	14.0	8.8
	1	50	73.2	1.9	7.3	0.2	23.4	1.5	0.5	0.4	4.8	0.8	6.1	0.6	2.3	0.6	16.4	8.3
	2	1	73.0	1.2	7.4	0.1	23.2	1.3	0.5	0.3	6.0	2.8	6.3	0.5	2.0	0.5	19.4	7.3
	2	50	73.2	0.8	7.3	0.2	23.0	1.6	0.5	0.4	5.8	2.9	5.7	0.8	2.5	0.6	15.8	12.0
1991	1	1	83.7	23.5	7.3	0.1	21.1	3.6	0.7	0.4	6.6	2.2	6.1	0.4	2.4	0.8	23.0	23.9
	1	50	75.4	4.0	7.3	0.1	22.1	2.0	1.5	2.1	7.4	3.9	6.2	0.7	2.4	0.5	113.9	232.1
	2	1	74.3	4.4	7.4	0.1	23.0	0.6	0.7	0.5	8.4	5.9	6.4	0.4	2.3	0.3	22.4	13.8
	2	50	75.0	1.7	7.3	0.2	25.9	8.0	0.8	0.4	6.1	4.1	6.1	0.6	2.2	0.4	29.4	25.3
1992	1	1	72.8	1.3	7.1	0.1	20.4	0.8	0.7	0.3	4.2	0.4	5.9	0.7	2.5	0.8	20.5	9.2
	1	50	74.3	0.5	7.1	0.1	20.8	0.4	0.5	0.1	8.0	4.8	6.2	0.5	2.3	0.5	19.7	9.3
	2	1	74.2	0.8	7.2	0.1	21.0	0.0	0.6	0.3	8.2	4.3	6.2	0.7	2.5	1.0	18.2	7.6
	2	50	73.8	0.4	7.0	0.1	20.7	0.4	0.7	0.5	4.2	2.5	6.0	0.9	2.2	0.4	14.6	4.4
1993	1	1	80.3	5.2	7.3	0.6	23.1	2.5	1.1	1.3	3.5	0.8	6.7	1.6	2.2	0.6	15.8	9.7
	1	50	89.2	28.0	7.0	0.4	22.3	2.3	1.0	0.6	3.5	0.8	6.2	0.7	2.8	1.0	23.0	15.1
	2	1	79.8	5.6	7.3	0.6	23.6	2.8	0.8	0.6	4.8	2.4	6.5	1.2	2.5	0.4	15.0	7.6
	2	50	78.3	2.4	7.0	0.1	21.8	0.8	0.4	0.1	4.5	2.1	6.1	0.6	2.5	0.4	13.7	7.3

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Appendix A2.–Page 2 of 6.

		Depth	Sp. Cond.		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(m)	(µ mhos/cm)	SD	(Units)	SD	(µ g L)	SD	(NTU)	SD	(Pt units)	SD	(µ g L)	SD	(µ g L)	SD	(µ g L)	SD
1994	1	1	77.3	0.8	6.9	0.4	21.8	1.3	0.4	0.1	8.5	1.5	6.3	0.5	2.2	0.3	7.7	9.1
	1	50	78.7	2.3	6.9	0.3	21.9	0.9	0.3	0.1	8.0	1.5	6.3	0.5	2.4	0.7	5.3	4.4
	2	1	77.3	1.0	7.0	0.3	22.1	0.8	0.4	0.1	9.2	2.3	6.1	0.4	2.5	0.7	18.2	25.2
	2	50	77.7	0.8	6.9	0.3	22.3	0.9	0.7	0.9	7.8	3.3	6.1	0.4	2.3	0.3	31.2	48.1
1995	1	1	76.0	3.1	6.8	0.1	21.7	0.5	1.0	0.7	4.2	1.5	5.6	0.2	2.4	0.3	10.8	4.6
	1	50	75.4	1.5	6.9	0.1	22.5	2.0	0.7	0.5	5.5	2.3	5.8	0.5	2.8	0.8	9.0	6.0
	2	1	76.3	2.8	7.0	0.1	22.3	0.7	0.7	0.6	3.7	1.2	5.8	0.3	2.3	0.5	11.3	6.3
	2	50	76.0	2.0	6.9	0.2	22.8	1.2	0.7	0.6	6.3	4.6	5.8	0.3	2.3	0.5	11.3	5.4
1996	1	1	77.0	2.8	7.0	0.2	22.4	0.6	0.6	0.2	4.2	0.8	5.5	0.1	2.6	0.2	10.7	4.5
	1	50	77.3	3.0	7.0	0.1	22.6	1.1	0.6	0.3	4.8	1.8	5.5	0.1	2.6	0.2	8.8	4.0
	2	1	76.8	1.5	7.2	0.1	22.0	0.4	0.6	0.4	4.0	0.6	5.5	0.1	2.6	0.2	13.5	9.6
	2	50	77.7	2.4	7.0	0.1	22.0	0.5	0.6	0.2	5.8	3.5	5.5	0.1	2.6	0.2	7.7	1.4
1997	1	1	75.7	3.3	7.6	0.3	24.8	2.6	0.5	0.1	7.8	5.6	5.8	0.9	2.5	0.4	13.8	3.9
	1	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	50	75.2	0.4	7.4	0.1	23.6	0.6	0.5	0.1	5.7	1.4	5.4	0.2	2.4	0.5	11.5	5.3
	2	1	75.3	0.5	7.5	0.0	24.1	1.0	0.5	0.1	5.3	2.2	5.5	0.2	2.5	0.4	12.5	5.5
	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	50	75.0	0.6	7.4	0.1	23.7	0.6	0.4	0.1	7.5	2.1	5.4	0.3	2.7	0.4	10.8	5.0
1998	1	1	72.3	0.5	7.4	0.1	24.5	2.0	1.0	0.4	7.5	3.4	5.8	0.2	2.4	0.1	11.5	5.7
	1	50	73.8	0.5	7.3	0.1	22.9	0.7	0.7	0.4	5.5	0.6	5.7	0.1	2.5	0.0	9.3	4.6
	2	1	74.0	0.8	7.4	0.1	24.6	1.9	1.0	0.7	5.8	2.9	5.7	0.1	2.5	0.1	10.8	5.9
	2	50	72.0	3.4	7.3	0.0	23.7	1.5	0.6	0.4	5.0	0.8	5.7	0.1	2.5	0.1	9.3	5.3
1999	1	1	70.3	1.7	7.2	0.3	22.3	0.7	0.4	0.1	4.0	0.8	5.7	0.1	2.6	0.1	28.3	16.0
	1	50	71.5	1.7	7.2	0.2	22.4	0.5	0.6	0.5	3.5	1.3	5.9	0.1	2.4	0.0	29.0	16.8
	2	1	71.2	1.3	7.1	0.2	22.4	0.8	0.6	0.4	4.2	0.8	5.7	0.1	2.5	0.2	25.8	15.3
	2	50	72.0	0.7	7.1	0.2	22.1	0.4	0.6	0.4	3.2	0.4	5.7	0.1	2.5	0.1	24.4	10.6

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Year	Station	Depth (m)	Sp. Cond. (µ mhos/cm)	SD	pH (Units)	SD	Alkalinity (µ g L)	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (µ g L)	SD	Magnesium (µ g L)	SD	Iron (µ g L)	SD
2000	1	1	ND	ND	7.6	0.2	13.3	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.6	0.2	13.7	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2001	1	1	ND	ND	7.5	0.4	19.3	4.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.5	0.4	19.4	3.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2002	1	1	ND	ND	7.4	0.0	21.5	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.4	0.0	21.6	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2003	1	1	ND	ND	7.4	0.1	21.6	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.3	0.0	21.6	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2004	1	1	76.5	0.0	7.2	0.2	21.7	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	5	ND	ND	7.2	0.2	21.5	0.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	10	ND	ND	7.2	0.2	21.4	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	15	ND	ND	7.2	0.2	21.5	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	20	ND	ND	7.1	0.2	21.1	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	25	ND	ND	7.2	0.1	21.0	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	30	ND	ND	7.2	0.2	20.9	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	35	ND	ND	7.2	0.2	21.1	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	50	ND	ND	7.1	0.1	21.0	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.2	0.1	21.3	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	5	ND	ND	7.2	0.1	21.6	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	10	ND	ND	7.2	0.1	21.5	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	15	ND	ND	7.2	0.1	20.9	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	20	ND	ND	7.2	0.2	21.1	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	25	ND	ND	7.2	0.1	21.0	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	30	ND	ND	7.2	0.1	21.0	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	35	ND	ND	7.2	0.2	20.7	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	50	ND	ND	7.1	0.1	21.3	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	5	1	68.2	0.0	7.1	0.2	30.6	12.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	6	1	ND	ND	7.1	0.2	21.8	3.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

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		Depth	Sp. Cond.		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(m)	(μ mhos/cm)	SD	(Units)	SD	(μ g L)	SD	(NTU)	SD	(Pt units)	SD	(μ g L)	SD	(μ g L)	SD	(μ g L)	SD
2005	1	1	ND	ND	7.1	0.1	21.4	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	5	ND	ND	7.1	0.1	21.1	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	10	ND	ND	7.1	0.1	21.2	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	15	ND	ND	7.1	0.1	21.0	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	20	ND	ND	7.1	0.1	21.1	0.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	25	ND	ND	7.1	0.1	20.8	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	30	ND	ND	7.1	0.1	20.7	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	35	ND	ND	7.1	0.1	20.7	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	50	ND	ND	7.1	0.1	20.7	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.1	0.1	21.4	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	5	ND	ND	7.1	0.1	21.4	0.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	10	ND	ND	7.1	0.1	21.3	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	15	ND	ND	7.1	0.1	21.4	0.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	20	ND	ND	7.1	0.1	21.0	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	25	ND	ND	7.1	0.1	20.8	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	30	ND	ND	7.1	0.1	21.0	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	35	ND	ND	7.1	0.1	20.9	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	50	ND	ND	7.1	0.1	20.7	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	5	1	ND	ND	7.1	0.1	31.6	9.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	6	1	ND	ND	7.1	0.1	23.1	5.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

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Year	Station	Depth (m)	Sp. Cond. (μ mhos/cm)	SD	pH (Units)	SD	Alkalinity (μ g L)	SD	Turbidity (NTU)	SD	Color (Pt units)	SD	Calcium (μ g L)	SD	Magnesium (μ g L)	SD	Iron (μ g L)	SD
2006	1	1	ND	ND	7.3	0.1	21.9	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	5	ND	ND	7.3	0.1	21.3	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	10	ND	ND	7.3	0.1	21.5	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	15	ND	ND	7.3	0.1	21.5	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	20	ND	ND	7.3	0.1	21.3	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	25	ND	ND	7.3	0.1	21.3	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	30	ND	ND	7.3	0.1	21.2	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	35	ND	ND	7.3	0.1	21.3	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	50	ND	ND	7.3	0.1	21.3	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.3	0.1	21.6	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	5	ND	ND	7.3	0.1	21.8	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	10	ND	ND	7.3	0.1	21.3	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	15	ND	ND	7.3	0.1	21.3	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	20	ND	ND	7.3	0.1	21.2	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	25	ND	ND	7.3	0.1	21.3	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	30	ND	ND	7.3	0.1	21.3	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	35	ND	ND	7.3	0.1	21.1	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	50	ND	ND	7.3	0.1	21.1	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	5	1	ND	ND	7.2	0.1	28.7	5.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	6	1	ND	ND	7.3	0.1	19.8	2.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

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		Depth	Sp. Cond.		pH		Alkalinity		Turbidity		Color		Calcium		Magnesium		Iron	
Year	Station	(m)	(µ mhos/cm)	SD	(Units)	SD	(µ g L)	SD	(NTU)	SD	(Pt units)	SD	(µ g L)	SD	(µ g L)	SD	(µ g L)	SD
2007	1	1	ND	ND	7.3	0.0	22.7	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	50	ND	ND	7.4	0.0	22.7	0.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.4	0.0	22.5	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	50	ND	ND	7.4	0.0	22.2	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2008	1	1	ND	ND	7.2	0.1	21.9	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	50	ND	ND	7.2	0.0	21.6	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.2	0.1	21.8	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	50	ND	ND	7.2	0.1	21.4	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2009	1	1	ND	ND	7.4	0.2	22.0	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	50	ND	ND	7.4	0.2	12.6	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.5	0.2	21.0	1.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	50	ND	ND	7.5	0.2	20.9	2.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2010	1	1	ND	ND	7.2	0.3	20.1	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1	50	ND	ND	7.1	0.2	20.2	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	1	ND	ND	7.1	0.2	19.9	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2	50	ND	ND	7.0	0.2	19.8	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Appendix A3.–Summary of seasonal mean nutrient and algal pigment concentrations by station and depth for Spiridon Lake, 1988–2010.

Year	Station	Depth (m)	Total - P (μ g L)	SD	Total Filter-able - P (μ g L)	SD	Filterable Reactive - P (μ g L)	SD	Total Kjel-dahl - N (μ g L)	SD	Ammonia (μ g L)	SD	Nitrate + Nitrite (μ g L)	SD	Reactive Silicon (μ g L)	SD	Chlorophyll *a* (μ g L)	SD
1988	1	1	3.8	1.4	3.0	1.1	2.5	1.2	102.8	11.4	9.9	2.7	220.5	26.0	2,171	160	0.45	0.1
	1	50	3.8	0.6	2.2	0.6	1.7	0.5	94.9	9.0	11.2	5.5	256.9	9.6	2,279	172	0.16	0.1
	2	1	3.5	0.1	2.0	0.6	1.8	0.3	100.5	11.3	7.8	6.6	221.3	11.1	2,283	170	0.40	0.1
	2	50	4.0	0.6	1.9	0.6	1.8	0.5	91.4	9.9	8.6	4.4	236.2	27.5	2,237	157	0.29	0.1
1989	1	1	3.6	0.7	3.7	1.9	3.0	2.2	103.4	7.6	8.5	2.5	207.1	35.4	2,162	214	0.19	0.1
	1	50	4.2	1.0	3.2	1.2	2.4	0.4	97.9	18.6	11.5	7.3	242.8	54.9	2,277	353	0.32	0.2
	2	1	6.1	3.7	2.7	1.0	2.5	0.4	114.8	45.7	9.5	5.2	197.9	61.9	2,129	119	0.18	0.1
	2	50	7.3	7.8	2.7	0.7	2.7	0.7	104.0	40.1	12.5	11.0	209.8	50.4	2,173	109	0.37	0.3
1990	1	1	3.5	1.8	2.4	0.6	2.0	0.8	92.5	16.5	4.9	2.0	203.4	36.8	2,114	93	0.23	0.1
	1	50	3.0	0.7	2.8	0.5	2.0	0.6	85.3	10.9	6.3	2.5	228.5	24.8	2,171	96	0.34	0.2
	2	1	2.4	0.6	4.1	3.2	3.3	2.4	83.2	6.4	4.7	1.7	185.0	79.4	2,127	80	0.24	0.1
	2	50	2.5	0.8	2.8	1.1	2.9	1.9	87.7	12.3	6.6	2.8	187.3	80.1	2,205	109	0.24	0.1
1991	1	1	4.9	5.9	2.8	0.8	2.6	0.9	93.7	7.3	7.6	4.4	234.0	38.1	2,082	57	0.38	0.1
	1	50	5.2	3.7	3.3	2.0	2.8	1.4	87.5	12.9	9.4	4.8	265.1	20.9	2,131	54	0.20	0.1
	2	1	3.6	0.8	4.8	3.3	4.6	3.3	91.8	8.6	8.2	4.5	237.0	29.6	2,081	66	0.35	0.1
	2	50	3.8	1.5	3.6	3.3	3.4	3.2	88.6	7.4	11.3	5.8	267.7	7.7	2,137	46	0.25	0.1
1992	1	1	3.7	0.6	2.1	0.7	1.5	0.5	89.6	10.1	1.5	0.8	239.5	12.3	2,082	131	0.27	0.1
	1	50	4.9	1.4	4.2	3.1	3.7	3.0	87.0	8.0	4.6	3.3	258.7	16.9	2,111	102	0.22	0.1
	2	1	3.6	0.3	2.6	1.4	2.4	1.4	98.4	18.2	1.7	0.6	235.2	25.9	2,025	90	0.27	0.2
	2	50	4.5	0.8	3.1	2.8	2.0	1.1	83.2	24.8	5.3	3.7	273.4	7.7	2,112	46	0.23	0.1
1993	1	1	2.7	0.9	2.2	1.1	1.6	0.8	93.6	11.2	2.4	1.5	231.6	37.6	2,023	164	0.75	0.2
	1	50	3.0	0.9	3.0	4.0	1.8	1.8	90.7	10.8	5.2	3.4	240.2	22.8	2,122	94	0.42	0.2
	2	1	2.9	1.0	3.2	3.5	2.6	3.3	97.0	12.0	1.8	0.5	230.3	41.5	2,026	163	0.77	0.3
	2	50	2.5	0.1	3.2	2.5	2.8	2.5	85.4	3.8	5.4	3.7	247.7	30.6	2,128	96	0.40	0.2

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Year	Station	Depth (m)	Total - P (µg L)	SD	Total Filter-able - P (µg L)	SD	Filterable Reactive - P (µg L)	SD	Total Kjel-dahl - N (µg L)	SD	Ammonia (µg L)	SD	Nitrate + Nitrite (µg L)	SD	Reactive Silicon (µg L)	SD	Chlorophyll *a* (µg L)	SD
1994	1	1	3.2	1.3	1.9	1.5	1.5	1.1	101.8	3.9	3.2	4.7	204.3	22.1	2,092	131	0.26	0.2
	1	50	3.9	2.0	1.2	0.2	1.1	0.4	97.5	16.1	6.7	3.6	218.1	18.3	2,184	95	0.21	0.1
	2	1	2.8	0.7	2.2	1.5	1.4	0.9	105.7	12.8	1.6	1.3	202.1	17.2	2,144	77	0.31	0.1
	2	50	3.3	1.2	2.2	1.3	1.9	1.1	105.6	13.2	5.8	2.5	225.7	20.6	2,190	85	0.20	0.1
1995	1	1	3.4	2.2	0.9	0.1	0.9	0.2	108.8	12.3	2.2	1.6	203.1	26.8	2300	95	0.95	0.5
	1	50	3.4	1.3	1.5	0.3	1.4	0.4	105.6	20.4	3.5	2.4	241.6	6.6	2340	105	0.58	0.4
	2	1	3.9	2.0	1.2	0.4	1.1	0.2	125.2	24.1	2.2	1.0	213.4	19.8	2297	75	1.02	0.4
	2	50	3.2	0.9	0.9	0.2	0.9	0.1	108.2	18.6	4.5	3.0	243.1	9.1	2329	102	0.58	0.5
1996	1	1	2.7	0.6	1.5	0.9	1.0	0.5	113.4	34.1	5.1	2.8	183.6	18.5	2042	93	0.49	0.2
	1	50	3.0	1.1	1.3	0.7	1.0	0.4	90.5	18.5	9.3	5.0	210.8	9.0	2148	51	0.51	0.2
	2	1	2.7	0.7	1.4	0.7	1.1	0.3	105.5	20.7	5.6	1.6	180.2	14.4	2083	82	0.47	0.1
	2	50	4.4	1.7	1.5	0.7	1.5	1.3	101.1	16.9	10.2	4.1	217.9	2.4	2179	82	0.57	0.3
1997	1	1	3.0	0.6	3.4	3.5	3.5	4.1	103.6	12.0	11.2	5.8	147.4	31.1	2155	64	0.57	0.3
	1	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.58	0.4
	1	50	2.8	0.7	1.8	0.4	1.8	0.5	90.5	5.2	11.1	6.3	191.0	19.7	2223	98	0.38	0.2
	2	1	3.1	0.9	3.2	3.3	3.1	3.2	106.1	11.3	11.2	6.4	168.2	25.2	2139	103	0.59	0.3
	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.57	0.3
	2	50	3.8	1.5	3.1	1.0	3.2	1.0	107.4	30.3	10.7	6.2	188.3	17.5	2205	83	0.44	0.2
1998	1	1	4.8	1.6	2.7	1.8	1.7	1.0	138.3	20.5	8.4	6.1	121.5	24.7	2239	174	0.43	0.3
	1	50	4.0	0.4	1.6	0.8	1.3	0.5	118.4	10.1	10.2	5.4	174.4	19.6	2355	42	0.14	0.0
	2	1	3.9	1.2	1.5	1.1	1.4	0.6	124.6	10.1	4.9	1.4	148.3	12.2	2262	105	0.38	0.3
	2	50	4.0	1.7	1.5	0.9	1.5	0.7	122.9	12.0	9.6	4.5	171.9	26.4	2297	93	0.21	0.1
1999	1	1	4.0	2.5	1.9	0.5	1.5	0.5	93.0	4.8	6.4	2.9	188.0	33.8	2432	141	0.49	0.3
	1	50	3.2	0.4	1.7	0.7	1.2	0.5	92.0	2.7	6.9	3.8	211.4	6.1	2478	208	0.15	0.0
	2	1	2.7	0.3	2.3	0.7	1.7	0.4	103.5	14.3	6.2	4.1	193.4	24.0	2465	152	0.30	0.2
	2	50	3.0	0.6	2.3	1.6	1.7	1.4	87.9	15.3	11.2	6.0	208.1	10.1	2525	157	0.25	0.1

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Year	Station	Depth (m)	Total - P (μg L)	SD	Total Filter-able - P (μg L)	SD	Filterable Reactive - P (μg L)	SD	Total Kjel-dahl - N (μg L)	SD	Ammonia (μg L)	SD	Nitrate + Nitrite (μg L)	SD	Reactive Silicon (μg L)	SD	Chlorophyll *a* (μg L)	SD
2000	1	1	7.0	4.5	3.4	3.8	2.3	2.2	ND	ND	8.7	8.6	195.5	1.8	ND	ND	0.58	0.1
	2	1	6.1	8.7	3.3	4.6	2.0	2.0	ND	ND	7.5	8.0	184.0	15.7	ND	ND	0.77	0.2
2001	1	1	4.9	3.3	3.5	2.1	1.9	2.0	101.2	8.0	4.6	4.7	193.8	6.7	ND	ND	0.60	0.3
	2	1	6.7	5.1	3.5	3.3	2.7	3.5	ND	ND	2.1	1.3	189.2	7.3	ND	ND	0.60	0.1
2002	1	1	3.3	2.6	1.5	0.9	3.0	1.9	96.7	14.5	5.0	2.3	136.5	7.9	ND	ND	0.32	0.0
	2	1	4.0	1.9	1.3	1.3	1.9	1.0	ND	ND	3.4	1.7	135.0	21.2	ND	ND	0.45	0.2
2003	1	1	5.7	0.8	2.8	3.4	2.6	1.7	100.3	10.1	2.6	2.1	203.3	36.7	ND	ND	0.70	0.4
	2	1	3.5	0.7	1.4	1.1	3.6	0.8	ND	ND	1.9	2.0	201.3	22.1	ND	ND	0.60	0.3
2004	1	1	4.4	2.9	0.9	0.9	1.5	1.1	98.7	47.6	6.8	2.1	197.3	19.1	2165	217	0.60	0.2
	1	5	3.6	1.8	ND	ND	0.8	1.3	ND	ND	4.9	1.0	160.2	19.2	2214	146	0.48	0.2
	1	10	4.6	1.7	ND	ND	1.0	1.5	ND	ND	5.8	2.2	162.0	18.1	2207	111	0.54	0.2
	1	15	11.6	20.9	ND	ND	1.2	1.8	ND	ND	5.3	1.8	168.6	17.8	2215	108	0.54	0.3
	1	20	3.9	2.2	ND	ND	1.0	1.5	ND	ND	5.6	2.1	173.0	14.6	2242	110	0.63	0.3
	1	25	3.6	1.7	ND	ND	1.5	2.6	ND	ND	6.7	2.3	179.0	11.1	2277	114	0.48	0.2
	1	30	6.2	5.0	ND	ND	0.6	1.0	ND	ND	7.5	2.3	174.1	22.4	2298	115	0.59	0.3
	1	35	6.3	4.5	ND	ND	0.7	1.1	ND	ND	8.3	3.0	182.3	11.8	2377	195	0.56	0.4
	1	50	4.8	5.1	ND	ND	0.7	1.1	ND	ND	7.7	3.0	199.7	11.5	2365	144	0.61	0.2
	2	1	4.6	4.4	2.0	3.9	2.0	0.9	109.9	73.1	7.2	1.3	186.4	19.6	2223	183	0.82	0.7
	2	5	5.5	3.7	ND	ND	1.8	0.7	ND	ND	5.8	1.9	168.6	30.1	2201	171	0.51	0.2
	2	10	6.6	4.8	ND	ND	2.1	1.3	ND	ND	4.3	0.6	161.0	19.8	2205	166	0.46	0.2
	2	15	7.4	5.1	ND	ND	2.0	1.2	ND	ND	5.1	0.2	170.6	14.2	2237	189	0.56	0.3
	2	20	7.6	4.3	ND	ND	1.6	1.2	ND	ND	4.7	0.5	176.7	11.6	2265	174	0.46	0.2
	2	25	6.8	3.8	ND	ND	1.9	1.4	ND	ND	4.3	0.5	180.8	10.9	2332	213	0.46	0.4
	2	30	5.0	2.2	ND	ND	1.9	0.9	ND	ND	4.6	0.0	173.7	18.7	2327	199	0.49	0.3
	2	35	7.8	3.9	ND	ND	2.9	3.5	ND	ND	5.2	1.0	187.6	8.7	2416	226	0.52	0.4
	2	50	10.0	7.3	ND	ND	2.3	1.9	ND	ND	7.9	3.3	200.3	12.0	2402	222	0.49	0.2
	5	1	8.2	3.7	ND	ND	3.8	1.2	ND	ND	11.5	6.6	71.9	135.4	4504	1063	0.30	0.2
	6	1	15.7	7.6	ND	ND	2.8	2.6	ND	ND	8.1	4.8	42.8	64.1	1897	1079	1.08	0.5

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Year	Station	Depth (m)	Total - P (μ g L)	SD	Total Filter-able - P (μ g L)	SD	Filterable Reactive - P (μ g L)	SD	Total Kjel-dahl - N (μ g L)	SD	Ammonia (μ g L)	SD	Nitrate + Nitrite (μ g L)	SD	Reactive Silicon (μ g L)	SD	Chlorophyll *a* (μ g L)	SD
2005	1	1	2.7	1.2	1.8	1.5	0.5	1.2	147.4	135.4	4.7	1.6	139.5	28.2	2083	315	0.51	0.2
	1	5	2.5	1.4	ND	ND	0.4	1.0	ND	ND	6.4	1.8	140.1	27.8	2169	158	0.50	0.2
	1	10	2.9	1.3	ND	ND	0.1	0.3	ND	ND	6.3	1.6	139.9	25.5	2170	163	0.47	0.2
	1	15	2.3	0.9	ND	ND	0.1	0.2	ND	ND	6.3	1.7	146.6	23.9	2171	167	0.63	0.2
	1	20	2.4	1.6	ND	ND	0.2	0.4	ND	ND	10.9	9.7	142.3	23.9	2181	170	0.58	0.1
	1	25	2.4	1.1	ND	ND	0.1	0.3	ND	ND	7.1	1.5	154.4	14.4	2212	136	0.53	0.1
	1	30	1.9	1.0	ND	ND	0.1	0.2	ND	ND	7.8	2.6	156.6	15.1	2228	142	0.40	0.1
	1	35	2.2	1.1	ND	ND	0.1	0.3	ND	ND	9.2	2.7	160.6	12.2	2242	120	0.36	0.2
	1	50	3.9	1.2	ND	ND	0.2	0.4	40.1	31.4	10.0	2.5	163.7	11.9	2263	115	0.26	0.2
	2	1	4.1	0.7	1.0	0.9	0.5	0.7	152.6	62.0	4.9	2.0	142.5	15.6	2147	154	0.52	0.2
	2	5	ND	ND	ND	ND	0.3	0.6	ND	ND	4.7	2.3	142.7	16.2	2146	170	0.51	0.2
	2	10	ND	ND	ND	ND	0.3	0.4	ND	ND	4.9	2.1	143.7	17.2	2156	171	0.56	0.3
	2	15	ND	ND	ND	ND	0.3	0.7	ND	ND	5.3	2.3	152.0	18.1	2181	167	0.64	0.4
	2	20	ND	ND	ND	ND	0.5	0.8	ND	ND	6.0	1.9	163.1	21.8	2260	90	0.53	0.2
	2	25	ND	ND	ND	ND	0.7	1.1	ND	ND	6.7	1.9	164.6	23.4	2228	138	0.49	0.3
	2	30	ND	ND	ND	ND	0.4	0.6	ND	ND	6.8	2.9	167.0	24.1	2247	137	0.33	0.2
	2	35	ND	ND	ND	ND	0.7	0.8	ND	ND	6.9	3.1	159.7	28.6	2237	130	0.32	0.2
	2	50	5.1	2.1	ND	ND	0.3	0.6	139.8	44.7	7.6	2.7	169.7	24.4	2256	120	0.29	0.2
	5	1	8.2	3.1	ND	ND	0.1	0.2	ND	ND	6.6	1.2	38.1	56.3	3755	562	0.49	0.4
	6	1	9.3	3.3	ND	ND	0.2	0.3	ND	ND	8.5	4.4	70.4	100.2	1761	1144	1.11	0.4

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Year	Station	Depth (m)	Total - P (µ g L)	SD	Total Filter-able - P (µ g L)	SD	Filterable Reactive - P (µ g L)	SD	Total Kjel-dahl - N (µ g L)	SD	Ammonia (µ g L)	SD	Nitrate + Nitrite (µ g L)	SD	Reactive Silicon (µ g L)	SD	Chlorophyll *a* (µ g L)	SD
2006	1	1	1.4	1.3	1.7	0.2	1.0	0.5	255.9	166.5	7.0	1.4	182.7	15.3	2497	149	0.68	0.2
	1	5	0.3	ND	ND	ND	1.0	0.9	ND	ND	3.4	1.4	148.2	24.0	2542	126	0.82	0.2
	1	10	2.3	0.8	ND	ND	1.1	0.8	ND	ND	3.2	1.4	152.2	12.1	2499	234	0.78	0.4
	1	15	ND	ND	ND	ND	1.0	0.7	ND	ND	3.6	1.2	158.3	12.7	2575	150	0.90	0.5
	1	20	1.8	1.5	ND	ND	0.9	0.8	ND	ND	5.0	2.0	163.9	9.5	2592	102	0.82	0.4
	1	25	0.3	ND	ND	ND	0.8	0.7	ND	ND	6.2	2.0	167.3	9.8	2591	123	0.86	0.4
	1	30	ND	ND	ND	ND	0.6	0.6	ND	ND	6.8	2.6	163.1	19.0	2543	232	0.77	0.4
	1	35	ND	ND	ND	ND	0.6	0.6	ND	ND	7.2	2.3	151.8	39.2	2544	230	0.71	0.4
	1	50	1.5	1.5	ND	ND	0.4	0.5	183.1	148.7	12.2	2.0	190.4	10.0	2652	198	0.53	0.2
	2	1	1.7	1.3	1.5	0.2	0.9	0.4	ND	ND	7.2	1.5	181.8	17.2	2523	183	0.74	0.2
	2	5	ND	ND	ND	ND	0.5	0.6	ND	ND	3.4	1.2	149.5	23.3	2559	263	0.86	0.3
	2	10	ND	ND	ND	ND	0.5	0.5	ND	ND	4.3	3.1	157.0	12.8	2656	185	0.87	0.3
	2	15	ND	ND	ND	ND	0.6	0.7	ND	ND	5.7	5.3	152.5	17.7	2525	256	0.86	0.3
	2	20	ND	ND	ND	ND	1.1	1.9	ND	ND	7.5	7.1	160.0	8.4	2553	201	0.88	0.4
	2	25	ND	ND	ND	ND	0.5	0.4	ND	ND	6.4	2.6	169.3	7.2	2593	214	0.82	0.5
	2	30	ND	ND	ND	ND	0.4	0.3	ND	ND	7.5	3.3	170.4	11.0	2615	206	0.71	0.4
	2	35	ND	ND	ND	ND	0.5	0.5	ND	ND	7.4	3.9	171.5	9.1	2629	274	0.56	0.3
	2	50	2.4	3.0	ND	ND	0.4	0.4	ND	ND	13.4	2.0	197.5	12.5	2662	193	0.61	0.4
	5	1	4.0	1.7	ND	ND	1.0	0.8	ND	ND	4.7	1.7	52.5	92.5	4433	544	0.56	0.3
	6	1	8.1	0.8	ND	ND	0.6	0.6	ND	ND	7.1	2.2	32.1	45.1	3050	866	1.12	0.3

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Year	Station	Depth (m)	Total - P (μ g L)	SD	Total Filter-able - P (μ g L)	SD	Filterable Reactive - P (μ g L)	SD	Total Kjel-dahl - N (μ g L)	SD	Ammonia (μ g L)	SD	Nitrate + Nitrite (μ g L)	SD	Reactive Silicon (μ g L)	SD	Chlorophyll *a* (μ g L)	SD
2007	1	1	2.3	0.6	1.0	0.7	0.4	0.1	127.8	27.8	5.1	1.5	171.0	23.2	ND	ND	0.64	0.4
	1	50	2.2	0.8	0.8	0.6	0.4	0.2	108.8	19.1	7.9	1.8	192.8	12.8	ND	ND	0.32	0.0
	2	1	2.1	0.9	0.8	0.4	0.6	0.3	ND	ND	5.8	3.4	165.6	25.6	ND	ND	0.58	0.4
	2	50	2.3	0.8	0.5	0.3	0.6	0.3	ND	ND	7.4	1.2	192.0	11.3	ND	ND	0.38	0.1
2008	1	1	2.1	0.4	0.9	0.3	1.7	1.6	105.8	68.3	4.4	1.0	186.6	20.3	ND	ND	0.71	0.6
	1	50	2.2	0.3	0.8	0.3	1.3	1.1	ND	ND	8.0	2.0	208.3	8.6	ND	ND	0.70	0.5
	2	1	2.7	0.4	1.1	0.8	1.0	1.1	76.0	56.2	4.6	1.6	178.4	13.5	ND	ND	0.64	0.4
	2	50	2.3	0.3	0.9	0.3	1.8	1.3	ND	ND	7.7	4.0	202.0	8.9	ND	ND	0.58	0.4
2009	1	1	3.0	1.2	0.5	0.5	1.7	0.9	130.0	58.4	4.4	1.3	185.8	16.5	ND	ND	0.54	0.3
	1	50	4.2	3.2	0.7	0.7	1.7	0.6	ND	ND	9.4	2.5	199.3	46.0	ND	ND	0.47	0.6
	2	1	2.5	1.2	1.1	1.1	1.8	0.7	103.0	57.1	4.8	1.6	193.2	14.4	ND	ND	0.34	0.2
	2	50	3.1	1.6	1.0	0.8	2.6	1.0	ND	ND	8.4	2.0	213.7	15.6	ND	ND	0.31	0.2
2010	1	1	1.8	0.3	1.3	0.4	1.1	0.4	87.6	35.9	4.2	1.0	179.5	25.4	2513	294	0.36	0.2
	1	50	2.2	0.1	1.1	0.4	0.9	0.2	ND	ND	8.2	4.3	187.8	10.7	2621	87	0.34	0.2
	2	1	2.6	0.8	1.1	0.4	0.9	0.2	108.2	24.4	4.2	1.4	180.8	23.3	ND	ND	0.47	0.2
	2	50	2.7	0.7	1.0	0.4	1.1	0.2	ND	ND	8.3	4.7	199.0	17.7	ND	ND	0.33	0.2

Appendix A4.–Spiridon Lake weighted mean density and biomass, by species, reported in m^2, 1987–2010.

	Diaptomus [a]			*Cyclops* [a]			*Bosmina* [a]			*Daphnia* [a]			*Holopedium* [a]			TOTALS	
	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass	Size	Density	Biomass
Year	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2	mm	no/m^2	mg/m^2
1987	131,369	503.5	0.96	225,318	425.8	0.74	65,287	203.4	0.57	54,140	133.4	0.75	5,573	93.2	1.17	481,687	1,359
1988	53,344	243.0	1.02	146,961	341.5	0.82	38,694	129.5	0.61	19,044	129.5	1.20	764	3.5	0.73	258,806	847
1989	95,436	292.5	0.89	317,795	386.0	0.60	33,559	101.0	0.56	18,949	83.0	0.96	3,344	23.0	0.82	469,082	886
1990	111,385	460.5	1.00	206,688	415.0	0.76	21,179	69.0	0.59	30,069	175.5	1.10	1,486	7.5	0.69	370,807	1,128
1991	113,778	400.7	0.94	329,343	561.9	0.70	6,786	19.8	0.55	32,956	150.9	0.99	824	18.0	0.76	483,688	1,151
1992	20,328	125.4	1.13	261,093	767.7	0.91	11,825	41.0	0.60	24,893	121.5	1.01	1,780	16.0	0.91	319,919	1,072
1993	11,047	58.9	1.06	269,740	455.4	0.70	16,211	40.4	0.51	23,932	72.3	0.80	3,738	35.2	0.83	324,668	662
1994	8,090	45.4	1.09	240,942	470.5	0.75	27,941	82.1	0.55	39,411	98.1	0.75	7,754	55.0	0.85	324,139	751
1995	12,816	117.3	1.30	213,531	479.3	0.81	29,839	74.2	0.51	28,966	77.5	0.78	19,836	167.0	0.83	304,987	915
1996	3,096	13.8	0.99	384,605	831.7	0.78	28,268	90.7	0.58	20,846	76.8	0.92	8,873	82.9	0.91	445,689	1,096
1997	3,176	26.3	1.26	119,126	287.1	0.82	31,962	89.1	0.54	25,177	105.4	1.00	17,551	131.9	0.84	196,993	640
1998	8,153	45.8	1.09	354,952	481.3	0.63	23,652	60.5	0.52	37,601	131.8	0.90	16,306	52.5	0.58	440,664	772
1999	5,488	27.2	1.06	73,291	155.8	0.78	18,420	60.3	0.58	10,929	37.9	0.92	6,900	28.4	0.63	115,028	310
2000	2,860	16.0	1.14	369,322	466.9	0.61	43,099	103.0	0.51	22,450	60.7	0.79	14,151	86.0	0.76	451,880	733
2001	4,736	46.6	1.34	65,786	171.1	0.85	33,155	94.1	0.55	39,435	124.6	0.84	14,710	158.0	0.97	157,821	594
2002	22,986	125.5	1.12	226,075	365.2	0.69	35,908	104.8	0.55	24,310	118.1	1.02	50,958	348.8	0.80	360,236	1,062
2003	32,677	142.1	1.01	168,425	218.6	0.62	92,258	173.8	0.45	44,984	89.0	0.68	16,720	112.2	0.80	355,063	736
2004	4,977	32.6	1.14	69,849	117.0	0.70	31,871	76.2	0.50	49,921	116.6	0.72	2,070	9.3	0.68	158,687	352
2005	2,239	10.0	0.99	79,485	127.4	0.69	87,265	203.6	0.50	56,098	94.7	0.63	23,073	200.5	0.80	248,159	636
2006	1,002	5.9	1.10	16,876	44.0	0.85	22,707	44.8	0.46	32,925	52.0	0.61	15,146	111.6	0.82	88,655	258
2007	2,763	15.8	1.13	24,982	70.3	0.88	32,657	64.5	0.46	37,354	61.4	0.61	14,262	73.3	0.73	112,017	285
2008	1,181	7.3	1.14	28,047	91.4	0.95	29,617	85.9	0.55	44,013	113.7	0.77	651	8.5	0.96	103,508	307
2009	7,718	59.2	1.24	185,318	420.9	0.81	47,373	135.8	0.55	8,785	21.3	0.73	18,822	162.7	0.90	268,015	800
2010	13,429	89.3	1.16	62,580	125.9	0.76	20,701	44.0	0.47	6,316	22.8	0.86	18,126	78.4	0.67	121,151	360
Mean	28,086	121.3	1.09	185,005	344.9	0.76	34,593	91.3	0.53	30,563	94.5	0.85	11,809	86.0	0.81	290,056	738

[a] Values based on mean density.

Appendix A5.–Temperatures (°C) measured at the 1- and 50-meter strata in the Spring (May–June), Summer (July–August), and Fall (September–October) for Spiridon Lake, 1993–2010.

	Spring		Summer		Fall	
Year	Surface	Bottom	Surface	Bottom	Surface	Bottom
1993	4.7	3.4	12.5	5.0	9.7	6.9
1994	6.0	4.1	14.5	5.0	9.5	5.8
1995	6.5	4.3	13.1	5.2	12.3	8.0
1996	8.5	4.5	13.4	5.0	9.6	5.3
1997	7.1	4.0	15.3	4.6	12.2	4.7
1998	3.7	3.5	12.4	5.2	8.3	6.1
1999	3.4	3.4	10.8	4.8	NA	NA
2000	6.6	4.1	13.1	4.7	9.0	5.5
2001	6.2	3.2	14.4	4.1	11.2	4.3
2002	6.2	3.7	13.7	4.7	10.8	4.9
2003	6.8	4.5	16.8	5.4	10.5	6.0
2004	5.3	3.7	16.5	5.3	9.8	5.8
2005	7.7	4.4	15.4	5.3	10.0	5.9
2006	6.2	3.9	12.1	4.9	10.4	5.6
2007	6.7	3.7	13.8	4.6	10.4	5.0
2008	6.3	3.8	11.5	5.0	10.5	5.1
2009	6.6	3.8	15.1	5.1	10.8	5.7
2010	3.9	3.0	12.2	5.3	12.9	5.5
Mean (1993–2009)	6.1	3.9	13.8	4.9	10.3	5.6

Note: Spring temperature corresponds to the average of May and June temperatures, summer temperature corresponds to the average of July and August temperatures, and fall temperature corresponds to the average of September and October measurements, if available.

Appendix A6.–Temperatures (°C) measured at the 1- and 50-meter strata by month, for Spiridon Lake, 1993–2010.

	May		June		July		August		September		October	
Year	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
1993	3.1	2.9	8.0	4.5	12.0	5.0	13.0	5.0	10.0	5.3	9.4	8.6
1994	3.8	3.5	8.3	4.7	12.5	5.0	16.4	5.0	12.4	5.2	6.5	6.5
1995	4.0	3.7	9.0	4.8	13.5	5.1	12.7	5.3	13.3	6.1	11.3	9.8
1996	6.8	4.1	10.1	4.8	12.9	4.9	13.9	5.1	11.9	5.2	7.4	5.5
1997	3.8	3.7	10.4	4.2	15.2	4.5	15.5	4.7	14.1	4.7	10.3	4.7
1998	3.7	3.5	ND	ND	10.8	5.1	13.2	5.3	ND	ND	8.3	6.1
1999	ND	ND	3.4	3.4	9.6	4.7	12.9	5.1	ND	ND	ND	ND
2000	4.2	3.7	7.8	4.4	13.1	4.8	13.1	4.7	ND	ND	9.0	5.5
2001	2.5	2.5	9.9	3.9	14.5	4.1	14.2	5.3	11.2	4.3	ND	ND
2002	3.0	2.8	9.4	4.5	13.5	4.7	14.2	5.4	10.8	4.9	ND	ND
2003	4.1	3.8	9.4	5.2	ND	ND	16.8	5.4	12.5	5.4	10.5	6.0
2004	3.3	3.1	9.4	4.9	ND	ND	16.3	5.3	12.6	5.4	8.6	5.9
2005	3.9	3.7	10.3	4.8	16.2	5.2	16.4	5.3	12.7	5.3	7.0	6.4
2006	3.0	3.0	7.8	4.0	ND	ND	13.9	5.2	11.0	5.4	8.4	6.1
2007	2.9	2.9	10.0	4.4	12.9	4.5	15.3	4.9	10.4	5.0	ND	ND
2008	3.6	3.4	9.5	4.4	11.5	4.6	14.1	5.3	10.5	5.1	ND	ND
2009	3.6	3.3	10.3	4.8	16.1	5.0	14.1	5.2	10.8	5.7	ND	ND
2010	1.6	1.5	6.2	4.5	11.8	5.1	12.3	5.1	12.9	5.5	ND	ND
Mean (1993–2009)	3.7	3.3	8.9	4.5	13.2	4.8	14.5	5.1	11.7	5.2	8.8	6.4

APPENDIX B. DAILY SMOLT COUNTS, HYDROACOUSTICS SURVEYS, SURVIVAL DATA, AND APPORTIONED HARVEST

Appendix B1.–Daily sockeye salmon smolt outmigration counts from Spiridon Lake, 1999–2010.

Date	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
23 Apr	0	0	0	0	0	0	0	0	0	0	0	0
24 Apr	0	0	0	0	0	0	0	0	0	0	0	0
25 Apr	0	0	0	0	0	0	0	0	0	0	0	0
26 Apr	0	0	0	0	0	0	0	0	0	0	0	0
27 Apr	0	0	0	0	0	0	0	0	0	0	0	0
28 Apr	0	0	0	0	0	0	0	0	0	0	0	0
29 Apr	0	0	0	0	0	0	0	0	0	0	0	0
30 Apr	0	0	0	0	0	0	0	0	0	0	0	0
1 May	0	0	0	0	0	0	0	0	0	0	0	0
2 May	0	11	0	0	0	0	0	0	0	0	0	0
3 May	0	9	1	0	0	0	0	0	0	0	0	0
4 May	0	12	0	0	0	0	0	0	0	0	0	0
5 May	0	15	0	0	0	0	0	0	0	0	0	0
6 May	0	25	5	0	0	7	20	0	0	0	0	0
7 May	0	107	2	0	0	11	3	0	0	0	0	0
8 May	0	47	6	0	0	5	18	0	0	0	0	0
9 May	0	182	4	0	6	59	11	0	0	0	0	0
10 May	0	90	29	0	5	87	2	0	0	0	0	0
11 May	0	48	27	0	4	45	0	0	0	0	0	0
12 May	0	36	19	18	14	36	13	0	0	0	0	1
13 May	2	34	186	7	4	71	15	0	0	0	0	11
14 May	296	199	319	10	26	39	44	0	0	0	0	1
15 May	6,835	314	2,037	21	214	111	23	0	11	0	57	0
16 May	13,396	812	1,243	244	499	410	6	0	1	0	64	0
17 May	11,231	1,052	9,385	239	146	196	39	0	22	0	97	0
18 May	39,484	6,544	13,919	255	97	0	110	0	7	0	5	0

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Date	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
19 May	1,871	20,641	2,685	42	53	192	187	0	13	0	1,059	162
20 May	1,927	8,908	36,752	142	16	1,177	346	87	11	0	362	0
21 May	1,312	32,823	58,067	304	250	3,783	652	103	11	0	1,414	5
22 May	366	73,736	17,773	30	322	651	1,409	87	4	0	10,879	0
23 May	1,147	19,966	10,407	29	452	6,154	3,446	15	93	0	15,208	486
24 May	228	54,811	194,029	7,906	242	18,208	3,712	54	2,132	0	588	464
25 May	1,660	24,604	49,581	12,956	821	20,748	476	39	2,272	0	20,735	2,177
26 May	1,671	43,324	168,398	8,394	0	34,305	1,117	79	5,550	7,042	375	1,323
27 May	17,217	54,719	252,675	36,165	1,000	15,673	5,453	1	7,991	10,330	2,595	5,423
28 May	516	48,296	155,436	36,080	639	49,671	20,496	0	45,939	7,945	11,564	2,630
29 May	394	38,355	124,346	84,090	1,278	160,867	13,026	6064	31,123	25,120	52,572	739
30 May	31,324	7,098	37,509	38,057	2,954	17,191	4,756	7933	26,164	2,723	31,695	103,079
31 May	21,618	13,817	51,019	33,450	5,712	14,221	3,832	4285	1,478	7,087	21,196	248,388
1 Jun	19,580	5,820	80,592	46,837	14,808	33,722	32,320	78233	17,955	44,697	272	109,162
2 Jun	365,272	28,697	16,084	20,849	16,287	11,234	44,720	62093	29,520	170,221	12,584	9,642
3 Jun	258,733	20,676	39,065	13,021	10,900	17,718	111,750	89771	18,788	68,300	43,453	52,265
4 Jun	53,796	16,956	90,013	6,263	12,902	23,137	105,905	79156	82,318	21,862	8,010	75,266
5 Jun	13,901	5,844	33,543	9,887	22,142	11,436	74,213	42471	16,889	35,475	55,102	5,956
6 Jun	5,781	1,069	12,078	25,512	6,844	10,642	106,764	47826	34,265	60,685	10,044	1,539
7 Jun	10,811	493	15,817	21,964	12,843	2,818	82,530	27918	14,673	6,236	2,235	4,020
8 Jun	11,644	9,783	2,259	9,520	3,538	4,702	35,705	2926	14,627	6,848	2,089	2,364
9 Jun	3,549	21,043	10,420	12,962	3,346	7,717	32,358	26342	16,839	13,276	6,954	3,219
10 Jun	56	42,662	3,758	10,132	7,698	12,454	173,879	9757	21,608	5,918	961	2,205
11 Jun	5,953	7,966	6,332	6,561	10,660	30,226	236,836	3695	5,399	11,361	143	8,875
12 Jun	16,825	3,059	7,484	5,644	13,739	11,909	74,579	5159	2,852	6,706	2,231	7,912
13 Jun	7,022	1,254	5,604	5,088	13,858	17,858	65,412	22359	5,836	4,490	5,041	1,641
14 Jun	3,508	214	5,346	9,081	11,020	5,039	60,112	6193	5,147	4,207	2,475	534

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Date	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
15 Jun	318	781	3,043	5,278	6,517	8,435	26,508	5963	7,729	2,384	754	373
16 Jun	421	6,269	3,052	7,346	5,808	4,068	21,123	4292	3,378	2,173	713	72
17 Jun	375	4,681	2,616	10,569	4,722	3,251	16,320	6680	2,800	1,066	423	1,664
18 Jun	593	22,647	523	9,899	5,762	2,247	9,707	3885	1,069	1,050	1,211	2,037
19 Jun	160	10,207	6,424	6,960	4,617	1,551	13,356	8042	5,491	2,558	666	5,905
20 Jun	310	5,410	1,286	1,426	2,695	1,092	8,248	4328	12,562	1,476	347	1,807
21 Jun	828	23,022	807	957	3,624	782	679	2556	2,631	2,694	450	280
22 Jun	336	5,624	543	3,357	3,852	562	769	1834	1,237	2,085	150	280
23 Jun	582	5,344	444	1,461	2,303	1,433	410	1390	161	1,051	36	279
24 Jun	33	10,447	649	5,952	574	739	4,636	890	6,063	329	218	512
25 Jun	40	10,385	338	3,530	2,975	266	2,630	471	3,931	68	68	511
26 Jun	24	15,874	632	828	1,168	644	1,271	373	3,157	63	445	784
27 Jun	530	3,096	319	1,728	1,813	1,011	2,048	651	4,822	183	108	784
28 Jun	373	2,730	418	281	3,314	583	1,838	0	1,853	139	13	783
29 Jun	462	3,034	750	127	3,328	2,173	0	374	1,003	228	0	476
30 Jun	565	5,495	7	466	2,154	1,508	0	20	528	428	0	476
1 Jul	0	1,818	99	0	1,627	654	927	40	1,193	0	0	477
2 Jul	394	1,814	17	0	1,525	0	1,247	61	978	0	132	462
3 Jul	52	1,336	0	0	1,334	0	438	463	1,355	0	0	462
4 Jul	92	2,340	0	0	685	0	670	0	422	0	130	462
5 Jul	70	365	0	0	1,198	1,925	0	0	126	0	0	462
6 Jul	39	2,120	0	0	3,925	0	254	0	2,836	0	0	466
7 Jul	90	1,232	0	0	1,947	0	0	0	0	0	0	10
8 Jul	24	0	0	0	792	198	0	0	0	0	0	10
9 Jul	29	1,252	0	0	1,279	0	0	0	300	0	0	10
10 Jul	0	0	0	0	1,381	0	0	0	312	0	0	10

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Date	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
11 Jul	273	3,985	0	0	568	0	0	0	0	0	0	0
12 Jul	0	0	0	0	627	0	0	0	0	0	0	0
13 Jul	64	4,000	0	0	0	0	0	0	2,436	0	0	0
14 Jul	0	804	0	0	3,056	3	0	0	0	0	0	0
15 Jul	52	0	0	0	1,239	0	0	0	0	0	0	0
16 Jul	0	0	0	0	2,720	0	0	0	1,500	0	0	0
17 Jul	0	1,000	0	0	1,374	0	0	0	0	0	0	0
18 Jul	0	0	0	0	1,012	0	0	0	0	0	0	0
19 Jul	0	1,000	0	0	4	0	0	0	0	0	0	0
20 Jul	63	0	0	0	0	0	0	0	0	0	0	0
21 Jul	0	718	0	0	1,026	0	0	0	0	0	0	0
22 Jul	0	0	0	0	172	0	0	0	0	0	0	0
23 Jul	0	3,409	0	0	192	0	0	0	0	0	0	0
24 Jul	0	0	0	0	331	0	0	0	0	0	0	0
25 Jul	0	6,000	0	0	110	0	0	0	0	0	0	0
26 Jul	0	0	0	0	0	0	0	0	0	0	0	0
27 Jul	0	0	0	0	0	0	0	0	0	0	0	0
28 Jul	0	1,500	0	0	1,432	0	0	0	0	0	0	0
29 Jul	0	0	0	0	0	0	0	0	0	0	0	0
30 Jul	0	0	0	0	297	0	0	0	0	0	0	0
31 Jul	0	0	0	0	0	0	0	0	0	0	0	0
1 Aug	0	3,000	0	0	0	0	0	0	0	0	0	0
2 Aug	0	0	0	0	1,033	0	0	0	0	0	0	0
3 Aug	0	0	0	0	0	0	0	0	0	0	0	0
4 Aug	0	0	0	0	0	0	0	0	0	0	0	0
5 Aug	0	0	0	0	0	0	0	0	0	0	0	0
6 Aug	0	0	0	0	1,400	0	0	0	0	0	0	0
Totals	936,118	788,909	1,536,221	521,925	262,851	577,655	1,409,374	564,959	479,411	538,504	327,923	669,343

Note: For daily sockeye salmon smolt outmigration counts from Spiridon Lake in years prior to 1999, refer to Thomsen (2010).

Appendix B2.–Juvenile sockeye salmon estimates based on hydroacoustic fish population surveys in Spiridon Lake, 1992, 1994–2004, and 2007.

		Total Fish Estimates [a]		
			95% Confidence Interval	
Year	Date	Number	Low	High
1992	13-Sep	470,587	263,248	677,926
1994	25-Apr	701,521	586,692	816,350
	24-Jun	132,793	85,712	179,874
	26-Sep	562,029	406,414	717,644
1995	2-May	770,610	624,763	916,457
	27-Jun	166,412	136,694	196,130
	29-Sep	1,463,235	970,958	1,955,512
1996	4-May	775,092	480,683	1,069,501
	1-Jul	119,466	98,065	140,867
	19-Sep	658,871	40,670	1,277,072
1997	28-Apr	719,530	520,732	918,328
	7-Jul	592,241	360,022	824,460
	11-Sep	1,577,625	1,203,260	1,951,990
1998	25-Apr	1,341,645	1,226,528	1,456,762
	15-Sep	2,041,377	1,664,655	2,418,099
1999	6-Oct	2,064,419	1,687,922	2,440,916
2000	13-May	1,681,691	1,449,089	1,914,293
2001	1-May	1,754,217	1,469,665	2,038,769
	23-Aug	2,331,383	1,843,645	2,819,122
2002	20-Aug	2,043,848	1,467,728	2,619,967
2003	8-Jul	95,576	44,724	146,428
2004	8-Jul	2,943,246	2,312,076	3,574,416
2007	13-Aug	667,929	483,516	852,342

[a] Total fish population estimates include all species residing in the lake. Townet sampling to determine species composition in the lake was attempted in 1992 and 1994, however, no rearing juvenile sockeye salmon were captured.

Appendix B3.–Sockeye salmon stocking and smolt survival estimates by age and stocking year, 1992–2010.

Juvenile Stocking			Smolt by Age							Juvenile	Smolt	Juvenile
			Age 1.	Percent	Age 2.	Percent	Age 3.	Percent	Total Smolt	to Smolt	to Adult	to Adult
Year	Stock	Number	Number	Survival	Number	Survival	Number	Survival	Produced	Survival (%)	Survival (%)	Survival (%)
1991	US	3,480,000	1,466,995	42.2	85,443	2.5	6,271	0.2	1,558,709	44.8	18.4	8.2
1992	US	2,200,000	260,115	11.8	244,360	11.1	831	0.0	505,306	23.0	23.2	5.3
1993	US	4,246,000	599,717	14.1	299,556	7.1	1,232	0.0	900,505	21.2	43.4	9.2
1994	US	5,676,000	314,604	5.5	135,414	2.4	2,934	0.1	452,952	8.0	29.9	2.4
1995	S	4,599,000	918,540	20.0	237,492	5.2	301	0.0	1,156,333	25.1	37.4	9.4
1996	US	4,844,000	654,293	13.5	216,923	4.5	373	0.0	871,589	18.0	31.9	5.7
1997	US	6,700,000	529,726	7.9	123,458	1.8	5,133	0.1	658,317	9.8	31.3	3.1
1998	S	3,340,000	812,267	24.3	493,529	14.8	0	0.0	1,305,796	39.1	32.3	12.6
1999	S	3,564,000	792,029	22.2	442,975	12.4	0	0.0	1,235,004	34.7	41.5	14.4
2000	S	4,397,100	1,093,246	24.9	92,484	2.1	914	0.0	1,186,644	27.0	34.6	9.3
2001	S	1,700,600	441,964	26.0	34,854	2.0	1,274	0.1	478,092	28.1	27.8	7.8
2002	S	952,900	228,857	24.0	36,882	3.9	4,264	0.4	270,003	28.3	25.9	7.3
2003	S	1,417,519	540,748	38.1	48,326	3.4	0	0.0	589,074	41.6	26.3	10.9
2004	S	2,797,644	1,368,763	48.9	94,932	3.4	0	0.0	1,463,695	52.3	21.4	11.2
2005	S	1,201,668	471,241	39.2	96,795	8.1	0	0.0	568,036	47.3	29.2	13.8
2006	S	3,196,512	387,179	12.1	426,010	13.3	0	0.0	813,189	25.4	–[c]	–[c]
2007	S	1,810,111	117,370	6.5	203,901	11.3	0	0.0	321,271	17.7	–[c]	–[c]
2008	S	1,049,809	132,681	12.6	148,048	14.1	–[a]	–[a]	280,729 [b]	26.7 [b]	–[c]	–[c]
2009	S	1,475,160	561,637	38.1	–[a]	–[a]	–[a]	–[a]	561,637 [b]	38.1 [b]	–[c]	–[c]
2010	S	3,006,265	–[a]	–[a]	–[a]	–[a]	–[a]	–[a]	–[a]	–[a]	–[c]	–[c]
Mean (1991–2005)			699,540	24.2	178,895	5.6	1,568	0.1	880,004	29.9	30.3	8.7
Mean-Saltery Stock (1995,1998–2005)			740,851	29.7	175,363	6.1	750	0.1	916,964	35.9	30.7	10.8
Mean-Upper Station Stock (1991–1994,1996–1997)			637,575	15.8	184,192	4.9	2,796	0.1	824,563	20.8	29.7	5.7

Note: Survival numbers reflect all smolt entering the bypass system (live and dead).
US = Upper Station Lake brood stock.
S = Saltery Lake brood stock.

[a] Awaiting smolt emigration.

[b] Numbers are incomplete. Awaiting smolt emigration.

[c] Numbers are incomplete. Awaiting adult returns.

Appendix B4.–Apportioned (includes estimated harvest outside SBSHA) commercial sockeye salmon harvest from Spiridon Lake enhancement by year, 1994–2010.

Year	Sockeye
1994	267,464
1995	96,621
1996	387,062
1997	147,245
1998	215,514
1999	468,220
2000	202,472
2001	147,295
2002	491,629
2003	633,449
2004	185,961
2005	144,857
2006	88,945
2007	171,341
2008	244,414
2009	155,025
2010	174,473
Mean (1994–2009)	252,970